Australian Government

Department of Agriculture, Water and the Environment

Consultation on Species Listing Eligibility and Conservation Actions

Notamacropus parma (parma wallaby)

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

1)   the eligibility of *Notamacropus parma* (parma wallaby) for inclusion on the EPBC Act threatened species list in the Vulnerable category; and

2)   the necessary conservation actions for the above species.

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

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

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

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

Please include species scientific name in Subject field.

or by mail to:

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

Responses are required to be submitted by 5 January 2022.

General background information about listing threatened species

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

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

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

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

Privacy notice

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

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

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

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

Information about this consultation process

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

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

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

CONSULTATION QUESTIONS FOR *Notamacropus parma* (Parma Wallaby)

SECTION A - GENERAL

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

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

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

PART 1 – INFORMATION TO ASSIST LISTING ASSESSMENT

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

Biological information

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

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

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

Population size

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

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

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

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

table below of possible species 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:

☐ <1000 ☐ 1000-4999 ☐ 5000-9999 ☐ >10 000

Level of your confidence in this estimate:

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

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

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

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

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

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

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

   Do you think that future population declines could exceed 30%, especially given the threat of climate change?

Evidence of total population size change

10. Are you able to provide an estimate of the total population size in 2003 *(at or soon after the start of the most recent three generation period)*? Please provide justification for your response. Are you able to provide an estimate of the total population size in 2010 *(at or soon after the start of the most recent 10 year period)*?

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

   ☐ <1000 ☐ 1000-4999 ☐ 5000-9999 ☐ >10 000

   Level of your confidence in this estimate:

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

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

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

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

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

11. Are you able to comment on the extent of decline in the species' total population size over the last approximately 18 years (3 generations) Please provide justification for your response.

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

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

    Level of your confidence in this estimated decline:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

    Level of your confidence in this estimated extent of occurrence

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

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

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

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

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

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

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

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

    Level of your confidence in this estimated extent of occurrence:

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

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

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

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

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

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

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

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

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

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

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

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

Level of your confidence in this estimated extent of occurrence

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

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

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

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

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

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

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

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

Level of your confidence in this estimated extent of occurrence:

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

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

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

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

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

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

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

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

21. To what degree are the identified threats likely to impact on the species in the future?

22. Are there any indications of over-grazing & degradation of the species' habitat by larger macropods?

23. Are the threats impacting on different populations equally, or do the threats vary across different populations?

24. Can you provide additional or alternative information on past, current or potential threats that may adversely affect the species at any stage of its life cycle?

25. Can you provide supporting data/justification or other information for your responses to these questions about threats?

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

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

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

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

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

29. 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?

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

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

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

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

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

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

PART 3 – ANY OTHER INFORMATION

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

Conservation Advice for
Notamacropus parma (parma wallaby)

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

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

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

Photo of *Notamacropus parma* (parma wallaby) © Copyright, Brian Gratwicke, CC-BY 2.0.

Conservation status

Notamacropus parma (parma wallaby) is proposed to be listed in the Vulnerable category of the threatened species list under the *Environment Protection and Biodiversity Conservation Act 1999.*

Notamacropus parma was assessed by the Threatened Species Scientific Committee to be eligible for listing as Vulnerable under criteria 2 and 3. The Committee's assessment is at Attachment A. The Committee assessment of the species' eligibility against each of the listing criteria is:

- Criterion 1: Not eligible

- Criterion 2: B2ab(i,ii,iii,v): Vulnerable

- Criterion 3: C1: Vulnerable

- Criterion 4: Not eligible

- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Vulnerable category are a limited geographic distribution and number of locations, continuing decline projected in the number of mature individuals and continuing decline inferred in the species' area of occupancy, extent of occurrence and area, extent and/or quality habitat due to fire, invasive species and land clearing. The species has a limited number of mature individuals and its overall population is projected to decline by 16 percent in the next three generations resulting from the 2019–2020 bushfires and other ongoing threatening processes.

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

Species information

Taxonomy
Conventionally accepted as *Notamacropus parma* Waterhouse (1845).

Description
The parma wallaby is a small wallaby from the family Macropodidae, with a head and body length of up to 528 mm and a tail length of up to 54 mm. The species' fur is a uniform greyish-brown on its back and shoulders, with a dark stripe along its spine ending mid-back. It has a white stripe on the cheek and upper lip and a white throat and chest. When hopping, the parma wallaby remains close to the ground in an almost horizontal position with its forearms tucked tightly against its body, and tail curved upwards in a shallow U-shape. The male is larger than the female and has a more robust chest and forelimbs. Males weigh up to 5.9 kg and females up to 4.8 kg (Maynes 2008). The species is difficult to distinguish from pademelons (*Thylogale* spp.), which have shorter, stiffer tails (Menkhorst & Knight 2001).

Distribution
The parma wallaby is endemic to New South Wales (NSW). It was thought to be extinct from the 1930s until 1965, when workers on Kawau Island, New Zealand, discovered it was part of a population of about 12 species of wallabies and other marsupials that had been brought over from Australia almost a century before (Wodzicki & Flux 1967). In 1967, a live female was

collected near Gosford NSW and subsequent surveys demonstrated that it still occurred in the state (Maynes 1977).
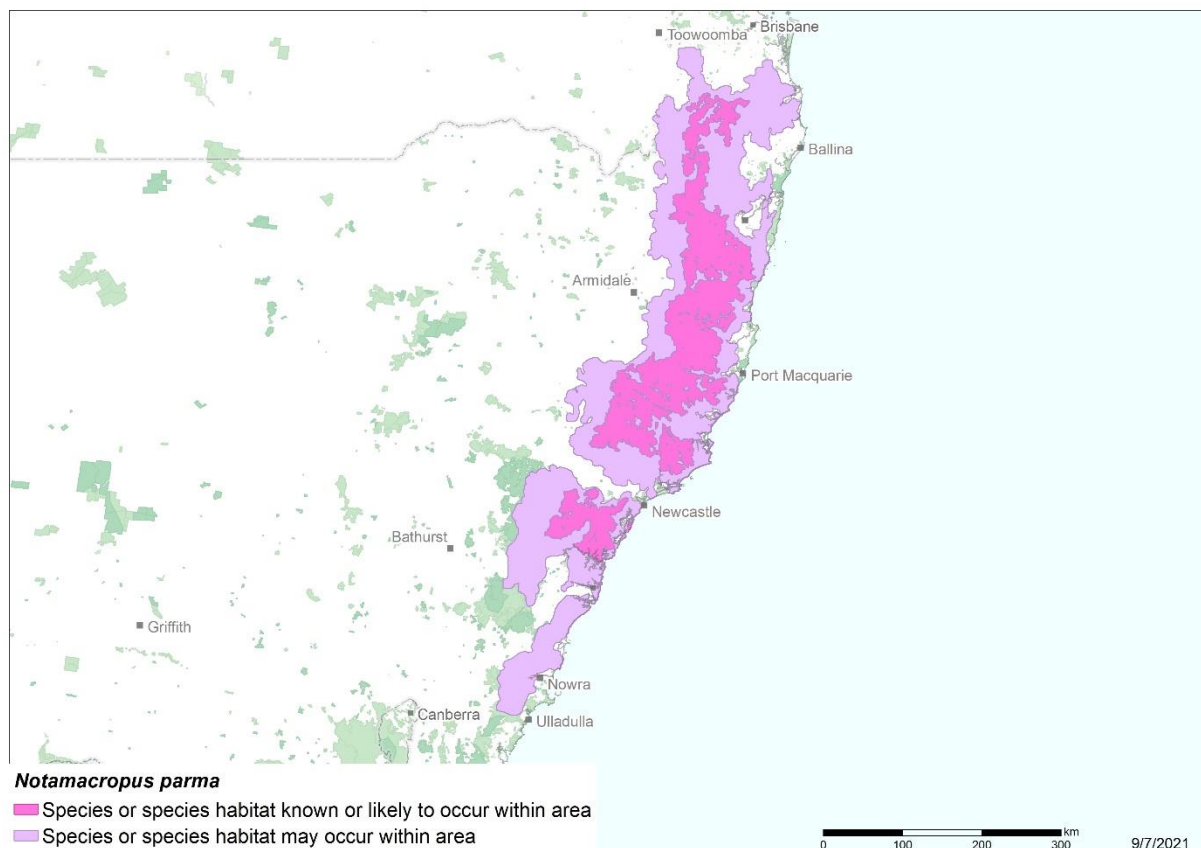
In NSW, the parma wallaby is patchily distributed along the Great Dividing Range. It is present in suitable forests scattered throughout the escarpment up to 1000 m above sea level. Upper altitudinal sites include the Dorrigo Plateau, Gibraltar Range and Barrington Tops (Lunney & McKenzie 2019). Its distribution extends from the area around Olney State Forest south west of Newcastle, to south of the Bruxner Highway between Tenterfield and Casino (Maynes 1977; 2008; DPIE 2021). The species was recorded north of the Bruxner Highway in the Border Ranges area until as recently as 2006 (Glen et al. 2006). However, it appears to have subsequently undergone a contraction from the northern end of its range (DPIE 2021; Tuckey K, pers comm. 5 July 2021). Extensive remote camera surveys and wild dog scat analysis in this area have failed to detect the species (McHugh et al. 2019; DPIE 2021; Goldingay et al. 2021).

The species' distribution includes land that is part of the Gondwana Rainforest of Australia World Heritage Listing.

Historical distribution

Maynes (1997) outlines the species' presumed historical distribution and notes that there has been a reduction in the species' distribution since European settlement, due to land clearing. In the late 1800s, the species was found south of Sydney in the Illawarra region and near Bega (Maynes 1977; Lunney & Leary 1988; Woinarski et al. 2014). The species is no longer found in coastal forests (Woinarski et al. 2014; Lunney & McKenzie 2019).

Map 1 Modelled distribution of *Notamacropus parma* (parma wallaby)

Notamacropus parma
- Species or species habitat known or likely to occur within area
- Species or species habitat may occur within area

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

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

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

Cultural and community significance

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

The cultural significance of the parma wallaby is not known. The word 'parma' comes from an NSW Indigenous language, however, the exact source word and language are unknown (Nash 2014). The parma wallaby is found across land belonging to multiple Traditional Owner cultural and dialect groups in NSW.

Relevant biology and ecology

Habitat ecology

The optimum habitat for the parma wallaby is wet sclerophyll forest with a thick, shrubby understorey and nearby grassy patches. The species also occurs in dry sclerophyll forest with a dense understorey and occasionally in rainforest (Maynes 1977; Fox & Read 1991; Maynes 2008). The parma wallaby shelters in the thick understorey through which it moves along runways (Woinarski et al. 2014). It is mainly nocturnal, and emerges from the cover of shrubs around dusk to feed on grasses and herbs at the edge of clearings (Maynes 2008).

Read and Fox (1991) compared sites at which parma wallabies were present with similar sites in nearby areas from which they were absent. Sites with parma wallabies appeared to have more *Imperata cylindrica* (blady grass) and *Rytidosperma* spp. (tussock grass) and fewer herbs and other grass than sites without parma wallabies. However, it was difficult to unequivocally identify structural parameters that determined the presence or absence of the species. Several reasons for this were considered, and it appears most likely that some of the sites from which parma wallabies were absent did indeed meet the habitat requirements of this species but remained unoccupied. This situation may result from the low subpopulation densities and relatively sparse, disjunct distribution of this species.

Lentle et al. (2004) calculated the mean home range size for free-ranging parma wallabies on Kawau Island New Zealand. Using 80 percent external convex polygons, the mean home range was estimated as 5.24 hectares (+/- 0.5). However, this is likely to be a lower home range compared to individuals living in Australia, given Kawau Island is only 20 km^2. There are no estimates of home range size for parma wallabies in NSW.

Diet

The parma wallaby feeds on grasses, herbs and to a lesser extent, fungi. Vernes (2010) found that mycophagy (fungus eating) was widespread among macropodids in north-east NSW, including the parma wallaby. Redenbach (1982, cited in Vernes 2010) indicated that fungus is consumed in considerably smaller amounts in the parma wallaby than in more heavily mycophagous marsupials (such as potoroos). Vernes (2010) found that the parma wallaby regularly consumed a diversity of fungus. This included a large proportion of hypogeous (below-ground) mycorrhizal species. Mycorrhizal fungi promote the healthy growth of vascular plants as they facilitate water and nutrient uptake, and increase drought tolerance and disease resistance (Claridge & May 1994; Claridge 2002). Dispersal of fungi by mycophagous marsupials is important in the maintenance and health of forest ecosystems (Johnson 1996), and the parma wallaby may be contributing to this process.

Reproductive and social ecology

Females of the parma wallaby become sexually mature at one year of age and males at 20–24 months. The species gives birth year-round, but most births occur between February and June/July (Maynes 1973, 1977, 2008). A single young is born after a gestation of 33–36 days. The young make their first excursions from the pouch around 23–25 weeks old and pouch life is estimated to be around 30 weeks (Maynes 1973). The species' expected lifespan is 10 years (Jones et al. 2009), although individuals have lived for up to 15.9 years in captivity (AnAge 2012). The species' generation length is estimated to be 4.5–6 years (Pacifici et al. 2013; Woinarski et al. 2014).

The parma wallaby is normally solitary, although groups of two (rarely three) are sometimes observed feeding. Larger aggregations occur in New Zealand on Kawau Island where the population density is much higher (Maynes 2008). As the species is small, mostly nocturnal, solitary and lives in densely forested areas, it is difficult to survey. There have been no robust estimates of population size for the species (Woinarski et al. 2014).

Habitat critical to the survival

Primary habitat for the parma wallaby is wet sclerophyll forest with a thick, shrubby understorey in association with grassy patches. It also occurs in dry sclerophyll forest with a dense understorey and occasionally rainforest.

Accordingly, the habitat critical to the survival of the parma wallaby includes:

- occupied forested habitats,
- unoccupied forested areas adjacent or near known occurrences, which can provide future habitat for natural range expansion, dispersal or translocation, and
- areas of habitat that supported the species in the past, but from which they are now absent.

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 parma wallaby include populations at the limits of the species' range, outlying populations, stronghold populations, research populations and other populations where recovery actions, such as predator control and reintroductions, are being implemented.

Six sites have been identified as priority management areas for the parma wallaby under the Saving Our Species program in NSW (DPIE 2021).

Threats

The parma wallaby is threatened by inappropriate fire regimes, land clearing, predation and competition with invasive species, land clearing and climate change.

Table 1 Threats impacting the parma wallaby

Threat	Status and severity [a]	Evidence
Habitat, loss disturbance and modification		
Inappropriate fire regimes	• Timing: current • Confidence: observed • Consequence: major • Trend: increasing • Extent: across the entire range	Since European settlement, fire regimes in south-eastern Australia have been significantly altered by a combination of disruption to Aboriginal fire management practices, 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. This change to fire frequency and extent, threatens forest-dwelling mammals in southern and south-eastern Australia (Lindenmayer 2015). The parma wallaby is vulnerable to mortality during and after bushfires, due to its limited ability to flee; use of understorey vegetation as shelter; specialised habitat requirements; preference for long-unburnt vegetation; large home range size (species with small home ranges may be more able to use small unburnt patches post-fire than those with requirements for large home ranges); susceptibility to competition or habitat degradation by introduced herbivores in a post-fire environment; and susceptibility to introduced predators (Legge et al. 2020). The 2019-2020 bushfires overlapped with an estimated 59 percent of the modelled range of the parma wallaby, with resultant population decline estimated at 24 percent (with 80% confidence range of 12-35%) one year after the 2019–2020 bushfires, and 16 percent (with 80% confidence range of 3-35%) over three generations following the fires (Legge et al. 2021). Fuel reduction burning occurs within the distribution of the parma wallaby. Like bushfires, planned burning that is overly frequent or intense, and regular burning of forest margins, can reduce or degrade parma wallaby habitat (DPIE 2018). High frequency, low intensity burns encourage open forest structures and remove the dense undergrowth that is a vital refugial habitat component for ground-dwelling mammals, like the parma wallaby (Johnson 1989; Claridge et al. 2000). Loss of understorey during planned burns may also enhance predation pressure from introduced taxa, such as the European red fox (*Vulpes vulpes*) and feral cats (*Felis catus*) (Hradsky 2020). However, fuel reduction burning may also reduce the risk of extensive high

Threat	Status and severity [a]	Evidence
		intensity bushfire impacting on large areas of parma wallaby habitat.
Land clearing	• Timing: historical/current • Confidence: observed • Consequence: moderate • Trend: increasing • Extent: across part of its range	Habitat loss and fragmentation is implicated in the decline of many small and medium-sized mammals (Bennett 1990; Law & Dickman 1998; Lindenmayer et al. 2000). There has been a reduction in the parma wallaby's range since European settlement due to land clearing for agriculture, urban development and timber harvesting (Maynes 1977; Lunney & Leary 1988). While 43 percent of the species' distribution occurs in reserves (DPIE 2021), loss and fragmentation of habitat are ongoing in most parts of the species' range (Woinarski et al. 2014). The other 57 percent of the species' distribution occurs in State Forests or on private land where private native forestry activities and vegetation removal or thinning may be permissible under the Local Land Services Act 2013 and Land Management (Native Vegetation) Code 2018 (DPIE 2019). Changes to land clearing legislation in 2013 have seen a recent significant increase in the rate of land clearing for agriculture in NSW, particularly in the northern part of the species' range (DPIE 2019).
Vehicle strike	• Timing: current • Confidence: observed • Consequence: minor • Trend: increasing • Extent: across part of its range	The creation and maintenance of roads and tracks in the species' habitat makes it susceptible to vehicle strike (DPIE 2021).
Invasive species		
Predation by the European red fox	• Timing: current • Confidence: observed • Consequence: moderate • Trend: static* • Extent: across the entire range *The trend represents the presence of foxes; however, other threatening processes (e.g., fire) may alter the impact foxes have on the parma wallaby.	The European red fox is known to prey on the parma wallaby and previous translocations of the species have failed due to predation by the European red fox (Lunney & McKenzie 2008). While foxes may not penetrate far into dense wet sclerophyll forest (Catling & Burt 1995), Parma wallabies may be exposed to predation when feeding at the grassy edges of the forest or along roads (Maxwell et al. 1996). Increased habitat fragmentation or incidence of fire in the species' habitat could result in greater exposure of individuals to predation by foxes (Lunney & McKenzie (2019). The European red fox is known to increase predatory activity into recently burnt areas (Meek & Saunders 2000; Hradsky 2020), except where small scale planned burns retain a mosaic of refugial vegetation (McHugh et al. 2020). Accordingly, loss of understorey following the 2019-2020 bushfires may have increased predator pressure on the parma wallaby. This threat may increase in future given projections of more frequent and intense bushfires in the species distribution due to increasingly severe fire weather.

Threat	Status and severity [a]	Evidence
Predation by wild dogs (*Canis familiaris*)	• Timing: current • Confidence: observed • Consequence: minor • Trend: static* • Extent: across the entire range *The trend represents the presence of wild dogs, however, other threatening processes (e.g., fire) may alter their impacts on the parma wallaby.	The term 'wild dogs' includes dingoes, feral dogs (i.e. wild-living dogs recently derived from domestic breeds), and hybrids between dingoes and domestic breeds. Many hybrids retain features characteristic of pure dingoes, and may be functionally similar or equivalent to pure dingoes. Wild dogs are recognised predators of medium-sized macropods, including the parma wallaby (Robertshaw & Harden 1985; 1986; Glen et al. 1996; 2006; DPIE 2018). However, the relationship between wild dogs and parma wallabies are likely to be complex, because of the variety of ways that dogs could affect the mammal community. Robertshaw & Harden (1985) found that the larger swamp wallaby (*Wallabia bicolor*) was the primary prey of dingoes in north-eastern NSW, and that dingo presence may suppress fox density. Dingos thus lowered both grazing competition and predation pressure for parma wallabies. Colman et al. (2014) also found that control of wild dogs in the range of the parma wallaby resulted in more foxes and larger macropods. This may lead to increased predation on the parma wallaby and competition for food resources. More broadly, Johnson & Van Der Wal (2009) found an interaction between wild dogs and European red fox abundance in the forests of eastern Australia, and suggest that European red foxes are consistently rare when wild dogs are abundant. Thus, the removal of wild dogs may expose the parma wallaby to greater intensity of predation pressure from mesopredators (e.g. European red foxes and feral cats). Parma wallabies in disturbed forests may be at higher risk of predation, as wild dogs prefer to move along roads and walking tracks (Newsome et al. 1983; Claridge 1998) and hunt most efficiently in areas near tracks.
Predation by feral cats (*Felis catus*)	• Timing: current • Confidence: inferred • Consequence: minor • Trend: static • Extent: across the entire range	Predation by feral cats may pose a threat to the parma wallaby. Feral cats have been shown to prey on mammals up to 4kg (Fancourt 2015) which is in the same weight range as adult female parma wallabies (3.2-4.8kg) (Maynes 2008) and within the weight range of juveniles (Hardman et al. 2016; Stokeld et al. 2016). Stobo-Wilson et al. (2021) found that cats were most likely to consume medium-sized mammals, with the likelihood of predation peaking for mammals of approximately 130 g. This suggests that juvenile parma wallabies may be more at risk than adults.
Habitat degradation and competition due to feral herbivores	• Timing: current • Confidence: suspected • Consequence: minor • Trend: increasing • Extent: across part of its range	Habitat degradation and grazing by introduced herbivores, such as feral horses (*Equus caballus*), cattle (*Bos primigenius*), feral pigs (*Sus scrofa*), European rabbits (*Oryctolagus cuniculus*) and feral deer (*Dama dama, Axis axis and Cervus spp.*) can remove the understorey and shrub layer, thus reducing the parma wallaby's available shelter (Tasker & Dickman 2004; Tasker & Bradstock 2006; Woinarski et al. 2014; DPIE 2021). They also compete for available food resources (DPIE 2018). These impacts are likely to be exacerbated by fire as the availability of food and habitat resources is reduced. Legge et al. (2020) ranks the parma wallaby as

Threat	Status and severity [a]	Evidence
		susceptible to competition or habitat degradation by introduced herbivores in a post-fire environment.
Weed invasion	• Timing: current • Confidence: suspected • Consequence: minor • Trend: increasing • Extent: across part of its range	Weeds can invade, establish and outcompete native vegetation, particularly following disturbance events such as fire (D'Antonio & Vitousek 1992) and logging. Although these effects are often short-lived, the process may directly impact food availability post-fire for native species. However, there is little information on the extent to which this is currently impacting the parma wallaby. Grassy weeds may increase fuel load and alter fire regimes (Setterfield et al. 2013; Milberg et al. 1995). These altered fire regimes can create conditions that are detrimental to native species.
Climate Change		
Changes to temperature and precipitation patterns	• Timing: current • Confidence: observed • Consequence: major • Trend: increasing • Extent: across the entire range	Climate change is projected to result in higher mean and median temperatures, reduced rainfall, and increased frequency and severity of drought across south-eastern Australia (CSIRO & Bureau of Meteorology 2015). Although the parma wallaby's response to drought conditions is unknown, reduced rainfall may impact the species' available habitat. Climate change is likely to exacerbate other threats to the parma wallaby, including inappropriate fire regimes. A warmer and drier climate is leading to an increase in the frequency, severity and scale of bushfires (CSIRO & Bureau of Meteorology 2015), and an increase in the duration of the fire season (BOM & CSIRO 2020). These changes are evidenced by the 2019–2020 bushfires, which were precipitated by years of drought. In NSW (Bureau of Meteorology 2020; DPI 2020).

Timing—identify the temporal nature of the threat;

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

Consequence—identify the severity of the threat;

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

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

Each threat has been described in Table 1 in terms of the extent that it is operating on the species. The risk matrix (Table 2 parma wallaby risk matrix) 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 parma wallaby risk matrix

Likelihood	Consequences				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Low risk	Moderate risk	Very high risk	Very high risk **Inappropriate fire regimes**	Very high risk

Likelihood	Consequences				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
				Changes to temperature and precipitation patterns	
Likely	Low risk	Moderate risk **Predation by feral cats** **Predation by wild dogs**	High risk **Predation by the European red fox** **Land clearing**	Very high risk	Very high risk
Possible	Low risk	Moderate risk **Habitat degradation due to feral herbivores** **Weed invasion** **Vehicle strike**	High risk	Very high risk	Very high risk
Unlikely	Low risk	Low risk	Moderate risk	High risk	Very high risk
Unknown	Low risk	Low risk	Moderate risk	High risk	Very high risk

Categories for likelihood are defined as follows:

Almost certain – expected to occur every year

Likely – expected to occur at least once every five years

Possible – might occur at some time

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

Unknown – currently unknown how often the incident will occur

Categories for consequences are defined as follows:

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

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

Moderate – population recovery stalls or reduces

Major – population decreases

Catastrophic – population extirpation/extinction

Priority actions have been developed to manage the threat particularly where the risk was deemed to be 'very high' (red shading) or 'high' (yellow shading). For those threats with an unknown or low risk outcome (green and blue shading) it may be more appropriate to identify further research or maintain a watching brief.

Conservation and recovery actions

Primary conservation objective

Population decline is arrested and reversed; geographic range is increased by reintroductions to parts of the range from which the species has disappeared; population connectivity is maintained/restored.

Conservation and management priorities

Fire

- Provide maps of known parma wallaby sites to local and state Rural Fire Services and seek inclusion of actions to mitigate impact to the parma wallaby.

- Develop and implement a fire management strategy that optimises the survival of the species during and after fires. This should include buffers that prevent bushfire or planned burns from impacting habitat and food sources, and could include post-fire control of introduced predators and herbivores, post-fire weed suppression programs, and post-fire population monitoring program.

- For areas that require prescribed burns, plan burns to both reduce the risk of bushfire, and optimise the diversity of habitat types required by the species. Ensure that adequate understorey cover is maintained in a high proportion of the parma wallaby habitat.

- Planning approvals should ensure that asset protection zones are located outside of parma wallaby habitat.

Habitat loss disturbance and modification

- Protect areas identified as climate change refuges; establish corridors to allow movement to future suitable habitat (based on modelling under climate change scenarios).

- Avoid or minimise further loss or fragmentation of habitat. Where feasible, restore and enhance habitat connectivity between subpopulations to allow safe movement of individuals.

- Outside of National Parks and other managed conservation areas, promote the conservation and management of the species' habitat through the establishment of voluntary conservation agreements and identify opportunities for the inclusion of key habitat in public land conservation areas.

- Liaise with land managers and consent authorities to ensure that intensive forestry operations are not implemented in areas of key habitat and that suitable vegetation corridors connecting areas of key habitat are maintained during logging operations.

- Liaise with land managers and consent authorities to ensure that intensive forestry operations are not implemented in areas of key habitat and that there are suitable vegetation corridors connecting areas of key habitat during logging operations.

- Work with relevant road management authorities to identify vehicle strike hotspots on roads fragmenting parma wallaby habitat and implement strategies aimed at reducing vehicle strike.

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

- Develop and implement strategies to control predation by the European red fox and wild dogs, as detailed in the relevant Threat Abatement Plans or management strategies (DEWHA 2008; DPI 2017; DPIE 2021).

- If evidence shows that feral cats are also substantially impacting the parma wallaby, control predation by these species as detailed in the relevant Threat Abatement Plan and management strategies (DoE 2015; DPIE 2021).

- Pay particular attention to the need for feral animal control and weed control after fire (planned or bushfire).

- Liaise with land management authorities regulating grazing on public lands to ensure sustainable grazing practices that maintain habitat requirements.

- Promote the registration and responsible management of domestic cats and dogs, targeting urban areas adjacent to known parma wallaby habitat.

Ex situ recovery actions

- Identify whether there is a need for captive breeding, translocations and reintroduction. For example, consider the potential for reintroductions to the northern part of the species' previous distribution.

- If there is a need, identify key areas and suitable habitats for a future release of captively bred animals and/or wild-to-wild translocations, and ensure those habitats are managed for future suitability.

- Ensure any proposals for captive breeding or translocations are developed collaboratively and focused on the best conservation outcomes for the species.

Stakeholder engagement/community engagement

- Engage and involve Traditional Owners in conservation actions, including the implementation of Indigenous fire management and other survey, monitoring and management actions.

- Identify and engage partners including local Councils, NRM regions, state agencies, Indigenous communities, landholders, community-based organisations and conservation management organisations that can assist with conservation actions.

- Where research identifies potential habitat for the species in areas that are privately-owned, liaise with landholders to provide information on the species and its habitat requirements, and encourage reporting of any sightings.

- Increase the recognition and support for the species' recovery by disseminating information on the species and its conservation status to the public.

Survey and monitoring priorities

- Undertake surveys to better define the species' distribution.

- Implement a long-term monitoring program of known and potential sites, in order to assess population size/trends across its range, the viability of subpopulations, and to identify important populations.

- Monitor and record the incidence of fire across the species' range, including responses of the species and its habitat to fire, and fire management.

- Monitor the abundance and impact of introduced predators across the species' range and assess the efficacy of management interventions, particularly responses to control of the European red fox and wild dogs (and any consequent potential increase in feral cats if found to be impacting on the species). Consider the interaction of these invasive species with fire, as well as the interaction of fire with invasive weeds, in the design of the monitoring.

Information and research priorities

- Identify an optimal fire regime for the parma wallaby, by assessing individual and population-level responses to a range of fire regimes, and modelling population viability across all fire scenarios.

- Assess the efficacy and impacts of management options to reduce the incidence of extensive, severe fire.

- Undertake research to identify key threats responsible for contraction of the species' range.

- Identify subpopulations that have the greatest viability or are important for other reasons (e.g. genetic diversity, connecting other populations across the landscape) and ensure that landscape planning and development do not negatively impact such subpopulations.

- Model habitat suitability under future climate change scenarios and identify and protect climate change refuges; improve understanding of impacts of climate change on the species, including on population viability.

Recovery plan decision

No recovery plan is in place for the parma wallaby. A Saving Our Species Strategy is in place for the species in NSW where it is listed as Vulnerable under state legislation (DPIE 2021). A decision about whether there should be a Recovery Plan for this species has not yet been determined. The purpose of this consultation document is to elicit additional information to help inform this decision.

Links to relevant implementation documents

Threat abatement plan for predation by feral cats (2015)

Threat abatement plan for predation by the European red fox (2008)

NSW saving our species strategy: Parma wallaby (*Macropus parma*)

NSW Wild Dog Management Strategy 2017–2021

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Attachment A: Listing Assessment for *Notamacropus parma*

Reason for assessment

This assessment follows prioritisation of a nomination from the TSSC.

Assessment of eligibility for listing

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

Key assessment parameters

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

Table 3 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	<10,000	1000	<10,000	There is no robust estimate of population size for the parma wallaby.
				Previous assessments of the species' conservation status estimate the number of mature individuals as between 1000 and 10,000 (Woinarski et al. 2014; Lunney & McKenzie 2019). Lunney & McKenzie (2019) note that this estimate is based on 1992 data, however the source of this data is not provided. Woinarski et al. (2014) considered this estimate to be of low reliability.
				The parma wallaby is described as patchily distributed and rare throughout its range (Maynes 1977; 2008).
				There are no other data on population size, therefore the estimate of less than 10,000 mature individuals has been used in the assessment.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Trend	Declining			The number of mature individuals is likely to be declining, due to a range of factors including mortality associated with loss of suitable habitat following the 2019-2020 bushfires.
				Estimates based on expert elicitation suggest population size will decline overall by 24 percent (with 80% confidence range of 12-35%) one year after fire, and 16 percent (with 80% confidence range of 3-35%) in 3 generations following the bushfires (Legge et al. 2021).
				The species appears to be contracting from the northern end of its range (DPIE 2021; Tuckey K, pers comm. 5 July 2021). This contraction in range is also likely to reflect a decline in the species' population size.
Generation time (years)	4.5–6 years	4.5 years	6 years	Woinarski et al. (2014) estimates the generation length as six years. Pacifici et al. (2013) estimates the species' generation length as 4.5 years. This estimate differs from Woinarski et al. (2014) as it uses a longer lifespan of 11.9 years (considering the species can live in captivity for up to 15.9 years) and a moderate change in the z parameter z=0.29 (rather than z=0.5).
				Therefore, a plausible range has been used in the assessment.
Extent of Occurrence	50,778 km²	50,778 km²	53,225 km²	The minimum plausible value is based on the mapping of point records from a 20-year period (2001–2021) 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). This estimate has been used in the assessment as the species' range is thought to be contracting.
				The maximum plausible value is from the Action plan for Australian Mammals 2012 (Woinarski et al. 2014), which has medium-high reliability, and is based on the mapping of point records from 1993–2012.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Trend	Contracting			A total estimated 59 percent of the species' modelled distribution was impacted by fire in the 2019-2020 bushfire season, resulting in a predicted population decline of 16 percent over three generations (Legge et al. 2021). It's not known how these estimates will affect the species EOO. However, prior to the 2019-2020 bushfires, the species' range was thought to be contracting from the north. Extensive remote camera surveys and wild dog scat analysis in this area have failed to detect the species (McHugh 2019; DPIE 2021; Goldingay et al. 2021).
Area of Occupancy	364–816 km²	364 km²	816 km²	The minimum plausible value has been calculated 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). The maximum plausible value is from the Action plan for Australian Mammals 2012 (Woinarski et al. 2014). This figure has a low-medium reliability, and is based on the mapping of point records from the 19-year period 1993–2012. Given the impacts of the 2019-2020 bushfires (59 percent of the species' modelled distribution was impacted by fire resulting in a predicted population decline of 16 percent over three generations) and likely contraction of the species from the northern end of its range, it's feasible to consider that the species' AOO is closer to the minimum value. However, the AOO may also be underestimated due to a lack of comprehensive surveys in the species distribution. Therefore, a plausible range has been used in the assessment.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Trend	Contracting			The species' AOO is likely to be contracting due to mortality associated with loss of suitable habitat following the 2019-2020 bushfires and other ongoing threats. A total estimated 59 percent of the species' modelled distribution was impacted by fire in the 2019-2020 bushfire season, resulting in a predicted population decline of 16 percent over three generations (Legge et al. 2021). The projected population decline for the species is likely to impact future AOO estimates.
Number of subpopulations	>10	Unknown	Unknown	The number of subpopulations is not known with certainty but is estimated to be >10 (low reliability) in the Action plan for Australian Mammals 2012 (Woinarski et al. 2014). There are no other data on subpopulations, therefore this estimate has been used in the assessment.
Trend	Declining			The number of subpopulations may be contracting, due to mortality associated with loss of suitable habitat following the 2019-2020 bushfires. Estimates suggest population size will decline overall by 16 percent (but could decline by as much as 37 percent, the lower 80 percent confidence bound) in three generations following the bushfires (Legge et al. 2020). This may result in a reduction in the number of subpopulations.
Basis of assessment of subpopulation number	The number of subpopulations is not known with certainty but is estimated to be >10 (low reliability) in the Action plan for Australian Mammals (Woinarski et al. 2014). Therefore, this estimate has been used in the assessment.			

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
No. locations	<10	<10	<10	Woinarski et al. (2014) estimated the number of locations as more than 10. However, bushfires can impact multiple subpopulations at one time and may result in the immediate loss of parma wallabies and ongoing declines as a result of loss of food and habitat resources. The 2019/20 fires were of such a large scale that they burned 59 percent of the species' range, leading to a 24 percent reduction in the population in a year. Given that under climate change we can expect such fires to become both more frequent and more intense, it is reasonable to conclude that there are less than 10 locations.
Trend	Declining			The intensity, frequency and scale of catastrophic bushfires will likely increase due to climate change. Accordingly, the number of locations in which a single bushfire can rapidly affect all individuals will likely decrease.
Basis of assessment of location number	The unprecedented impact of broadscale bushfires similar in scale to the 2019-2020 bushfires may affect well over 50% of the population in a single year, causing the loss of about a quarter of the entire population (Legge et al. 2021). Post-fire recovery in the parma wallaby is slow and is unlikely to meet pre-fire levels before the next catastrophic scale bushfire.			
Fragmentation	While some fragmentation of the parma wallaby's habitat has occurred due to historical and ongoing land clearing, there is no evidence the species' geographic distribution is severely fragmented.			
Fluctuations	Not subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals - no parameter was changed by an order of magnitude by the 2019-2020 bushfires.			

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

Criterion 1 evidence
Not eligible

Generation length

Jones et al. (2009) cited the lifespan of the parma wallaby to be 10 years. Females of the parma wallaby become sexually mature at one year of age (Maynes 1973, 1977, 2008). A generation length of 6 years was used in the Action Plan for Australian Mammals 2012 for the parma wallaby (Woinarski et al. 2014). Pacifici et al. (2013) estimated the species' generation length as 4.5 years. This estimate differs from Woinarski et al. (2014) as it uses a longer lifespan of 11.9 years (taking into account the species can live in captivity for up to 15.9 years) and a moderate change in the z parameter z=0.29 (rather than z=0.5). Therefore, a plausible range of 4.5–6 years has been used in this assessment.

Decline prior to 2019-2020 bushfires

The parma wallaby is likely to have suffered historical declines in population numbers following European settlement, resulting from habitat loss and fragmentation (Maynes 1977; Lunney & Leary 1988; Woinarski et al. 2014). The Action Plan for Australian Mammals 2012 states the trend in population size as decreasing (with a low reliability) (Woinarski et al. 2014).

Extensive remote camera surveys and wild dog scat analysis in the northern part of the species' distribution have failed to detect the species (DPIE 2021; Goldingay et al. 2021.) McHugh et al. (2019) conducted camera trap surveys across nine national parks in NSW in order to detect medium-sized terrestrial mammals. A total of 298 camera trap sites were operated for three

weeks over two monitoring periods between May 2016 and January 2017. This included three sites where parma wallabies have been previously recorded – Nightcap National Park (including Whian Whian State Conservation Area), Richmond Range National Park and Yabbra National Park. No parma wallabies were detected in any of the camera traps during the survey. Further work in the Richmond Range National Park collected 75 wild dog scats and four European red fox scats. No evidence of parma wallaby remains were found in any scats that were analysed (McClean D, pers comm. 22 July 2021).

These studies suggest that the species is contracting from the northern end of its range (DPIE 2021; Tuckey K, pers comm. 5 July 2021). This contraction in range is likely to be matched by a decline in the species' total population size. However, no data are available to estimate the rate of decline, now or in the past. Past and current population declines are likely due to habitat loss and other threats across the species' range.

Decline post 2019–2020 bushfires

Between September 2019 and March 2020, catastrophic bushfires burnt over 10 million hectares in south-eastern Australia (Gallagher et al. 2021; Legge et al. in press). The Threatened Species Recovery Hub, in response to these bushfires, undertook an assessment of fire-affected vertebrate species to estimate population declines for conservation status review. Expert elicitation was used to estimate the extent of population declines after fires of varying severity, and the predicted population trajectories out to three generations after the fire event. These estimates include population declines associated with other ongoing threats under current management scenarios, but with an assumption of no further large-scale fires. The elicited information on population response to fires of varying severity was combined with spatial estimates of the overlap between the species distribution and fire severity mapping. This analysis suggests that the *overall* population of the parma wallaby declined by 24 percent one year after the fire but may have declined by as much as 35 percent (the lower 80 percent confidence bound). By three generations, the overall population is predicted to decline by 16 percent of its pre-2019 level, but possibly as much as 37 percent (the lower 80 percent confidence bound). The overall estimate of 16 percent includes 9.4 percent decline due to the 2019-2020 bushfires and a 6.4 percent decline due to ongoing processes, such as impacts from invasive species and land clearing (Legge et al. 2021). These projection estimates are conservative, as they do not include the potential for future large-scale fire events within the three generation period, which would cause additional declines (Legge et al. 2021).

While this elicitation project indicates that the parma wallaby is likely to have experienced a population size reduction since the 2019-2020 bushfires and will continue to undergo decline due to the fires and other ongoing threats, the estimate of 24 per cent one year after fire, and 16 percent decline over three-generations, does not qualify the species for listing under Criterion 1. However, the elicitation suggests that the decline could be as much as 37% over three generations, which would qualify the species for listing, and further extensive bushfires over the three generation period would accentuate the decline.

The data suggest that the species is not eligible for listing in any category under this criterion as population declines may not exceed 30 percent in any three generation period. However, the purpose of this consultation document is to elicit additional information to better understand

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

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

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

Criterion 2 evidence
Eligible under Criterion 2 B2ab(i,ii,iii,v) for listing as Vulnerable

The Extent of Occurrence (EOO) is estimated at 50,778 km². This was based on the mapping of point records from 2001 to 2021, obtained from state governments, museums and CSIRO. The EOO was calculated using a minimum convex hull as outlined in the Guidelines for Using the IUCN Red List Categories and Criteria (IUCN 2019). The EOO does not meet the criteria for listing in any category under Criterion 2.

The Area of Occupancy (AOO) is estimated at between 364 km² and 816 km². The lower estimate is based on the mapping of point records from 2001 to 2021, obtained from state governments, museums and CSIRO and calculated using a 2x2 km grid cell method, as outlined in the Guidelines for Using the IUCN Red List Categories and Criteria (IUCN 2019). The upper estimate is taken from the Action Plan for Australia Mammals 2012 and is based on records from 1993 to 2012 (Woinarski et al. 2014).

Given the impacts on the 2019-2020 bushfires (59 percent of the species' modelled distribution was impacted by fire resulting in a predicted population decline of 16 percent over three generations) and likely contraction of the species from the northern end of its range, it's feasible to consider that the species' AOO is closer to the minimum value of 364 km². However, the AOO may also be underestimated due to a lack of comprehensive surveys in the species distribution. Therefore, a plausible range of 364–816 km² has been used in the assessment.

Severely fragmented and number of locations

While some fragmentation of the parma wallaby's habitat has occurred due to historical and ongoing land clearing, the species' geographic distribution is unlikely to be severely fragmented. Under the IUCN Guidelines "a taxon can be considered severely fragmented if most (>50 percent) of its total area of occupancy is in habitat patches that are (1) smaller than would be required to support a viable population, and (2) separated from other habitat patches by a large distance" (IUCN 2019). There is no evidence that this applies to the parma wallaby.

The minimum plausible value for the number of locations is four, based on the most recent impacts of the 2019-2020 bushfires, which caused loss of almost a quarter (24 percent) of the population within a year (Legge et al. 2021). It is therefore reasonable to assume that the maximum plausible value is less than 10 for the purpose of this assessment.

Continuing decline

Continuing decline in number of mature individuals (v) of the parma wallaby has been projected in the recent project undertaken by Legge et al. (2021) (see information under Criterion 1). This project projected that three generations post the 2019–2020 fire event, the parma wallaby's overall population is likely to have declined by 16 percent of its pre-2019 level, but possibly as much as 37 percent (lower 80 percent confidence bound). These declines are due primarily to the 2019-2020 bushfires, but with some decline attributable to ongoing threats such as inappropriate fire regimes, invasive species and land clearing.

Continuing decline is also inferred in the species' EOO (i) and AOO (ii) as surveys during 2016–2017 have failed to locate the parma wallaby in a number of previously recorded sites north of the Bruxner highway (McHugh et al. 2019). The species is thought to be contracting from the northern part of its distribution (DPIE 2021). Further, due to the number of range-wide threats to the habitat of the parma wallaby (see Table 1), a continuing decline in the area, extent and/or quality of habitat (iii) for the species is inferred.

Extreme fluctuations

Extreme fluctuations in population size, area of occupancy, extent of occurrence and number of locations or subpopulations are not known to occur.

Conclusion

The Committee considers that the parma wallaby's Area of Occupancy (AOO) is at least limited, its number of locations is limited, and continuing decline is projected in the number of mature individuals. Furthermore, continuing decline is inferred in the species' area of occupancy, extent of occurrence and area, extent and/or quality habitat. Therefore, the species has met the relevant elements of Criterion 2 to make it eligible for listing as at least in the Vulnerable category. Given uncertainty in the estimate of AOO, however, the species may be eligible for listing as Endangered, however a more reliable estimate of AOO is required to support this higher threat category.

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

Criterion 3 Population size and decline

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

Criterion 3 evidence
Eligible under Criterion 3 C1 for listing as Vulnerable

Number of mature individuals

There are no robust estimates of population size for the parma wallaby. However, based on expert elicitation in the Action Plan for Australian Mammals 2012 there are an estimated 1000–10,000 mature individuals (Woinarski et al. 2014). This estimate was given a low reliability. Lunney & McKenzie (2019) provide the same estimate for the IUCN Red List assessment, and state that this estimate is based on 1992 data. However, the source of these data is not provided.

The parma wallaby is described as patchily distributed and rare throughout its range (Maynes 1977, 2008). There are no estimates of the species' density.

Based on the information above, an estimate of less than 10,000 mature individuals has been used in the assessment.

Continuing decline

Continuing decline in number of mature individuals of the parma wallaby has been projected in the recent project undertaken by Legge et al. (2021) (see information under Criterion 1). This

project projected that three generations after the 2019–2020 fire event, the parma wallaby's overall population is likely to have declined by 16 percent of its pre-2019 level, but possibly as much as 37 percent (lower 80 percent confidence bound). These declines are due primarily to the 2019-2020 bushfires, but with some decline attributable to ongoing threats such as inappropriate fire regimes, invasive species and land clearing.

The Committee considers that the estimated total number of mature individuals of this species is limited, with a projected decline continuing at a substantial rate. Therefore, the species has met the relevant elements of Criterion 3 to make it eligible for listing as Vulnerable.

However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered 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

There is no robust estimate of population size or number of mature individuals for the parma wallaby. However, as per Criterion 3, it is likely that the number of mature individuals is between 1000 and 10,000 which is not considered low. Therefore, the species has not met this required element of this criterion.

Additionally, the parma wallaby does not meet the quantitative threshold for Vulnerable under sub-criterion D2. While the species may occur at five or fewer locations, the area of occupancy (AOO) is estimated to be 364–816 km^2 which is above the threshold for this criterion.

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

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

Criterion 5 Quantitative analysis

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

Criterion 5 evidence
Insufficient data to determine eligibility

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

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

Adequacy of survey
There have been no recent comprehensive surveys for the species. Further survey work is required to accurately determine the species distribution and population numbers.

Version history table

Document type	Title	Date [dd mm yyyy]
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