Australian Government
Department of the Environment

Consultation Document on Listing Eligibility and Conservation Actions

Pseudomys oralis (Hastings River Mouse)

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

1) the eligibility of *Pseudomys oralis* (Hastings River Mouse) for inclusion on the EPBC Act threatened species list in the vulnerable category; and

2) the necessary conservation actions for the above species.

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 and Energy.

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

or by mail to:

The Director
Marine and Freshwater Species Conservation Section
Biodiversity Conservation Division
Department of the Environment and Energy
PO Box 787
Canberra ACT 2601

Responses are required to be submitted by 03 July 2019.

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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'. 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: http://environment.gov.au/privacy-policy .

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.

Pseudomys oralis

Hastings River Mouse

Note: The information contained in this Conservation Advice was primarily sourced from 'The Action Plan for Australian Mammals 2012' (Woinarski et al. 2014). Any substantive additions obtained during the consultation on the draft will be cited within the advice. Readers may note that Conservation Advices resulting from the Action Plan for Australian Mammals show minor differences in formatting relative to other Conservation Advices. These reflect the desire to efficiently prepare a large number of advices by adopting the presentation approach of the Action Plan for Australian Mammals, and do not reflect any difference in the evidence used to develop the recommendation.

Taxonomy

Conventionally accepted as *Pseudomys oralis* (Thomas 1921).

Species/Sub-species Information

Description

The Hastings River Mouse is native to Australia and one of the rarest members of the genus *Pseudomys* (Meek et al. 2003). It is superficially similar in size and general appearance to the *Rattus fuscipes* (Bush Rat) – which it is often mistaken for – and the introduced Black Rat (*Rattus rattus*) (Pyke & Read 2002; Meek et al. 2013; Meek & Vernes 2016).

Adults weigh 90–100 g, with a head-body length of 130–170 mm and tail length of 110–150 mm (Kirkpatrick 1995). The fur is brownish-grey above and beige to greyish-white below. The tail is two toned, being dark brown above and white below, and the feet are distinctly white, with the fifth toe of the hind foot notably joining well backward of the other toes (Pyke & Read 2002).

The Hastings River Mouse can be distinguished from other rodents found in sympatry by its two-toned tail and narrow 1 mm band of black fur surrounding the eye (Kirkpatrick 1995; Pyke & Read 2002). Other distinguishing features include adult females having four teats instead of eight or ten as in the *Rattus* species (Tweedie & York 1993; Pyke & Read 2002).

Distribution

The Hastings River Mouse is endemic to Australia. It is patchily distributed along a section of the Great Dividing Range from north-east New South Wales to south-east Queensland, within a biogeographic subregion referred to as the Macleay-McPherson overlap zone (NSW DECC 2005). The present known range is considered to be from Warwick, Queensland to Muswellbrook, New South Wales (Woinarski et al. 2014). However, Pyke & Read (2002) report the southernmost point of the range to be Newnes near Lithgow, New South Wales (170 km further south). The species has been observed at elevations that range from 250 m to 1250 m (Pyke & Read 2002; Meek & Shields 2005).

Sub-fossil evidence suggests that the range of the Hastings River Mouse has undergone a significant contraction both before and after European arrival in Australia (Jerry et al. 1998; Pyke & Read 2002; Bilney 2010; Rowe et al. 2011). Range contraction has been estimated at 65 percent since European settlement and 75 percent since the Pleistocene (Smith et al.1996 cited in Woinarski 2014). As recently as 5000 years ago the range extended from Buchan in north-eastern Victoria to Maleny in south-eastern Queensland (Wakefield 1972 cited in Fox et al.1994).

Previously thought to be extinct, since its re-discovery in 1969 (Queensland) and 1981 (New South Wales) renewed interest in the species and increased surveying has resulted in a steady rise in the number of recorded locations (Pyke & Read 2002). Until the turn of the century only 400 individuals had been caught at 50 trapping locations (sites at least 1 km apart) (Fox et al.

1994; Pyke & Read 2002); whilst 74 separate trapping locations have been reported to the Commonwealth Department of the Environment and Energy between 2010 and 2017 alone. Meek & Shields (2005) report the observed increase in records since re-discovery as an indication that the population is healthier than previously believed. More recent larger capture sites in New South Wales include, Gibraltar Range, Styx River, Billilimbra State Forest and Marengo State Forests (Meek et al. 2003); and in Queensland, Lamington National Park and Gambubal State Forest (Rowe et al. 2011).

Relevant Biology/Ecology

The Hastings River Mouse occurs in open wet or dry sclerophyll forests and woodlands with native grass, sedge, fern or heath understorey (Pyke & Read 2002; Graham et al. 2005). From quantitative habitat surveys, the Hastings River Mouse appears to be primarily selecting habitat based on shrub-layer canopy cover in the 1–1.5 m layer, followed by the availability of shelter sites: primarily logs and head and butt residue. Rock piles and boulders are also important for shelter but studies have observed their usage at significantly less than those available. At ground level, leaf litter and grass are the most frequently used microhabitats (Meek et al. 2003; Graham et al. 2005, Meek et al. 2006).

Previously believed to be found predominately near watercourses (King 1984; Read 1993; Tweedie & York 1993; Pyke & Read 2002), spool-and-line and radio tracking habitat surveys have shown the Hastings River Mouse rarely uses riparian habitat even where available (Meek 2002; 2003; Meek et al. 2003). Individuals have been trapped across a wider range of topography than previously thought, including habitat considered to be 'unsuitable' under the *Hastings River Mouse Microhabitat Prediction Model* (detailed in NSW DECC 2005). Individuals have been trapped at the forest edge, outside of old growth forest (Meek 2003; Meek et al. 2003; 2006) and at grazed and frequently burnt sites (Tasker & Dickman 2004; Graham et al. 2005). Pre-harvest surveys in the State forests of New South Wales have confirmed the existence of several populations in forests with long histories of timber harvesting and burning (Meek et al. 2003; Meek 2004; Law et al. 2016).

The Hastings River Mouse is essentially granivorous, feeding predominantly on seeds and fruit when they are present, but depends on leaves and stems in winter. Fox et al. (1994) identified both monocotyledon and dicotyledon plant material in the diet with *Poaceae* species (grasses) making up to 55 percent of the diet in some sampled areas. The most common seeds selected were from *Juncus* species (rushes) and *Carex* species (sedges). Lesser food items include insects, flowers, pollen, fern sporangia and fungi (Fox et al. 1994). This dietary composition is similar throughout the range of the Hastings River Mouse, indicating it is relatively selective in its foraging (Fox et al. 1994; Pyke & Read 2002; Tasker & Dickman 2004; Meek et al. 2006). Unlike other *Pseudomys* species, the Hastings River Mouse does not appear to broaden its diet in winter, although it hasn't be established whether this is due to active selection or food availability (Fox et al. 1994).

The Hastings River Mouse is nocturnal (Meek et al. 2012) and during night time foraging it covers distances of around 200 m within a relatively small home ranges of around 2 ha (Pyke & Read 2002; Meek & Shields 2005; Meek et al. 2006). Studies show that individual home ranges can overlap (Pyke & Read 2002; Meek et al. 2006).

From available records, mating and gestation occurs between July and February, with most births occurring between July and March (Pyke & Read 2002). A study by Meek (2002) revealed no evidence of communal nesting and the number of offspring per pregnancy ranges from one to four, but is usually two to three (Pyke & Read 2002; Meek & Shields 2005). Pyke & Read (2002) state that females are able to produce more than one litter per year and Townley (2000) (cited NSW DECC 2005) contends that up to three litters can be produced in one season. This represents an extremely low reproductive rate compared to many rodents (Jerry et al. 1998). Individuals do not breed in the year of their birth and longevity is up to three years, making the generation length of this species two years (Townley 2000 cited in NSW DECC, 2005).

Hastings River Mouse populations appear severely fragmented. Genetic analysis has confirmed two evolutionary lineages recorded: a northern lineage and southern lineage overlapping at Washpool National Park, NSW (Jerry et al. 1998; Rowe et al. 2011). Smissen (2017) identified that the maternal mitochondrial haplotype genetic differences observed between the two lineages is not reflected in the nuclear genome, which exhibited only minor allele frequency differences. This indicates that the lineages do not represent distinct species, as previously proposed, and gene flow is more consistent with random mating. However, Smissen (2017) believes the genetic differences between the northern and southern lineages are great enough that they should be considered Evolutionary Significant Units.

Limited haplotype sharing in the maternal mitochondrial DNA is also exhibited between individuals caught at different localities within the same lineage, demonstrating low level of gene flow between subpopulations (Jerry et al. 1998; Rowe et al. 2011). This recorded mitochondrial genetic divergence indicates that populations are subject to both historical and contemporary isolation in pockets of refugia, following habitat contraction and fragmentation events, reconnecting when the distribution of suitable habitats in the region is available (Smissen 2017). This is consistent with similar pattern of genetic divergence reported for other rodents in the same biogeographical region (Bryant & Fuller 2014).

Elliott traps have predominantly been used in the detection of the Hastings River Mouse with camera traps being used as a more recent sampling tool (Meek & Falzon 2013; Law et al. 2016; Meek & Vernes 2016). Neither is optimal. Tasker & Dickman (2002) found that the sampling duration that is required to detect less common species with Elliott traps is large, with over a thousand trap nights required before individuals were caught. Camera traps provide for greater detection, as individuals do not have to respond and enter the trap. However, differentiating the Hastings River Mouse from other sympatric rodents is difficult from photographs (Meek et al. 2013; Meek & Vernes 2016). Even with traditional trapping methods the Hastings River Mouse has been confused with the Bush Rat and this may partially account for the scarcity of locality records (Read 1993).

Pyke & Read (2002) report most populations appear to be very small (under 10 individuals) and the apparent disappearance of the Hastings River Mouse from five sites during a 15 year period. However, this may be due to poor targeting of historical surveys. Early surveys focused on habitat associated with riparian features, had sub-optimal placement of traps (away from logs and rocks) or occurring at disadvantageous seral stage in the ecological succession cycle (Meek 2003; Meek & Shields 2005). Meek et al. (2006) observed swift occupation of newly created territories by the Hastings River Mouse in the Marengo State Forest, indicating that this population was healthy and capable of recruitment and immigration.

Threats

Table 1: Threats impacting the Hastings River Mouse in approximate order of severity of risk, based on available evidence.

Number	Threat factor	Threat type and status	Evidence base
1.0	Habitat loss and fragmentation		
1.1	Vegetation clearance/Habitat fragmentation	known current	Hastings River Mouse populations are largely genetically isolated (Jerry et al. 1998; Rowe et al. 2011) making re-establishment of a locally extirpated population via immigration unlikely. Habitat loss and fragmentation could further limit gene flow between neighbouring populations and isolate currently contiguous local populations (Jerry et al. 1998).

			The discrete and ephemeral nature of populations, together with their apparent low numbers at localities (Pyke & Read 2002), means the Hastings River Mouse is likely to be greatly affected by habitat fragmentation. Major causes of habitat loss and fragmentation are disturbance through forestry, land clearing, fire and grazing. These disturbances open up the understorey and may simplify the ground cover to a degree that is unfavourable to the Hastings River Mouse, potentially leading to increased predation pressure through lack of shelter (Tasker & Dickman 2004; NSW DECC 2005). However, studies indicate the Hastings River Mouse may benefit from a degree of disturbance (Sousa 1984; Pyke & Read 2002; Meek et al. 2003; Meek 2004; Tasker & Dickman 2004; Law et al. 2016) and active management to eliminate, or greatly reduce, disturbance may have serious ramifications for the species (Meek 2004).The Hastings River Mouse has been shown to occur at the forest edge and at grazed and frequently burnt sites (Catling & Burt 1997; Tasker & Dickman 2004; Graham et al. 2005). Pre-harvest surveys in the State forests of New South Wales have confirmed the existence of several populations in forests with a long history of timber harvesting and burning (Meek et al. 2003). Declines in capture numbers (by 60–82 %) have been recorded over time in previously sampled sites in transects where logging has been excluded (35–45 years since logging); with recently logged sites (between 7–15 years since logging) showing a higher level of occupation than sites where logging has been excluded (Law et al. 2016). These results conform to observations that native rodents can show rapid recovery after logging, particularly where shelter is retained for cover dependent species (Lindenmayer et al. 2010; Stephens et al. 2012; Law et al. 2016). Positive correlation with disturbance conforms to Fox's (1990) habitat-accommodation model, with the Hastings River Mouse, identified as an early-mid seral stage specialist, able to exploit resources after a disturbance before being excluded by the more dominant sympatric Bush Rat and *Rattus lutreolus* (Swamp Rat), which are late

			seral stage specialist (Monamy & Fox 2000; Tasker & Dickman 2004; Law et al. 2016).
1.2	Grazing	known current	Intensive grazing has been identified as a potential threat by fragmenting habitat through removal or trampling of foodstuffs and altering ground shelter cover (Tasker & Dickman 2004; NSW DECC 2005). In addition, floristics can be further altered by burning practices used by graziers as a management tool to promote feed for grazing stock (NSW DECC 2005). Despite the potential for habitat fragmentation, the specific effects of grazing on the Hastings River Mouse remain unclear (Meek & Triggs 1999). Low intensity grazing and fire can maintain a simplified understory suitable for the species (Law et al. 2016). Tasker & Dickman (2004) trapped the Hastings River Mouse in low intensity grazed forests, characterised by an open grassy understorey with a few scattered shrubs. Several studies, not targeting the Hastings River Mouse, recorded the species at frequently burnt and grazed sites (Catling & Burt 1997; Tasker & Dickman 2004) and almost all of the locations in National Parks and State Forests where the Hastings River Mouse is known to occur, were recently, or still are, subject to grazing and associated burning (Tasker & Dickman 2004). A degree of disturbance is believed to benefit the Hastings River Mouse, as an early-mid successional species, by encouraging the retention of critical habitat features and discouraging establishment of late successional species that are competitively dominant (Meek 2004;Tasker & Dickman 2004; Pereoglou et al. 2016).
2.0	Fire		
2.1	Too frequent burning	suspected current	Hastings River Mouse populations are largely genetically isolated (Jerry et al. 1998; Rowe et al. 2011) making reestablishment of a locally extirpated population via immigration unlikely. Frequent and/or severe fire events could result in extirpation of populations and increased habitat fragmentation. Fire events could further limit gene flow between neighbouring populations and isolate currently contiguous local populations (Jerry et al. 1998). T*he NSW Recovery Plan for the Hastings River Mouse (Pseudomys oralis) (2005)* identifies that pre- and post-logging burning

			to promote forest regeneration have the potential to adversely affect recovery by removal of hollow logs, which provide nesting sites and shelter from predation (NSW DECC 2005). However, the optimal fire regime to manage the recovery of the Hastings River Mouse has yet to be determined (NSW DECC 2005). Several studies have identified the Hastings River Mouse, as an early-mid seral stage specialist, which achieves highest abundance shortly after fire (Fox 1990; Smith & Quin 1997; Meek 2004; Tasker & Dickman 2004; Law et al. 2016). Populations are known to occur in areas burnt at frequencies of less than every 10 years and in some areas every two–five years (Meek et al. 2003; NSW DECC 2005). In addition, much of the Hastings River Mouse range is subject to frequent burning, indicating the species may be advantaged by frequent low-intensity prescribed burns (Catling & Burt 1997; Meek et al. 2003; Law et al. 2016). As an early-mid seral stage specialist, the Hastings River Mouse is able to become established shortly after a fire event, once the habitat reaches a threshold to fulfil their resource requirements (usually shelter). Fire regimes can prevent the regeneration of vegetation progressing to a stage where late seral stage specialists, such as the sympatric Bush Rat and Swamp Rat, can become established; thereby providing the Hastings River Mouse a competitive advantage (Fox 1990; Smith & Quin 1997; Monamy & Fox 2000; Tasker & Dickman 2004; Law et al. 2016). In addition, the Hastings River Mouse diet includes a mix of plant species that are promoted by moderately frequent burning (Tasker & Dickman 2004). Studies indicate that rather than time-since-fire, vegetation structure and community dynamics are a better predictor of species abundance (Sousa 1984; Fox 1990; Monamy & Fox 2000; Di Stefano 2010; Di Stefano et al. 2011) and therefore a better species recovery management tool than systematically imposed fire regimes.
2.2	Increase fire frequency/intensity due to climate change	suspected future	Current climate change predictions suggest that the number of extreme fire weather days will increase, providing conditions for a greater number and more severe wildfires (CSIRO & Bureau of Meteorology 2015). The

			effect of increased wildfire events is unknown but could result in a greater probability of local extirpation of Hastings River Mouse populations. The frequency and severity of wildfire could also promote less suitable habitat characteristics that are detrimental to the Hastings River Mouse (Tasker & Dickman 2004; Law et al. 2016).
3.0	Competition		
3.1	Increased competition with sympatric rodents	known current	The community composition of small mammals is related to landscape patterns and habitat suitability. Fire regimes and disturbance can encourage the retention of critical habitat features for early successional species and discourage establishment of late successional species (Meek 2004; Pereoglou et al. 2016). The Hastings River Mouse is an early-mid seral-stage specialist, able to exploit resources soon after disturbance. As the vegetation regenerates, late seral stage specialists, such as the sympatric Bush Rat and Swamp Rat, can become established as the habitat reaches a threshold to fulfil their resource requirements (usually shelter). These more dominant species can exclude the Hastings River Mouse through interspecific interactions (Fox 1990; Smith & Quin 1997; Monamy & Fox 2000; Tasker & Dickman 2004; Law et al. 2016). A study by Law et al. (2016) showed occupancy by the Hastings River Mouse declined steeply with an increased Rat abundance. It is therefore necessary for any active management to consider the effects of reduced disturbance given it can lead to a complex chain of interactions and leave vegetation conditions more suitable to competitively dominant species (Law et al. 2016).
4.0	Invasive species		
4.1	Predation by Red Fox (*Vulpes vulpes*)	suspected current	Red Foxes have been strongly implicated in the decline of rodents through direct predation and could be significant for small isolated populations, particularly those with low reproductive rates, such as the Hastings River Mouse. Even at low densities Red Foxes can eliminate remnant populations of threatened species (Smith & Quinn 1996). DEWHA (2008) identifies the Hastings River Mouse as a species affected by the Red Fox and the remains of a Hastings River Mouse have been found in Red Fox scat. However,

			as the Red Fox is a known scavenger, there is no study pointing to predation and little evidence that Red Fox predation is a key threat to the Hastings River Mouse (Meek & Triggs 1999; Law et al. 2016). In addition, sand pad surveys across many forests in northern NSW have indicated low to medium abundance of the Red Fox, inferring a low predation rate (Meek & Shields 2005). Concern exists that control efforts focused solely on Red Foxes may lead to an increase in Feral Cats (*Felis catus*) (Risby et al. 2000). Therefore, there is a need to better understand the impact of Red Foxes, non-target impacts of control measures, and Red Fox interactions with other species (DEWHA 2008). Shelter sites can limit predation and enable threatened species to co-exist with the Red Fox (Smith & Quinn 1996). Threat from predation could increase where there is excessive log removal, grazing or burning that reduces ground cover and shelter sites (Law et al. 2016).
4.2	Predation by Feral Cats (*Felis catus*)	suspected current	Feral Cats have been strongly implicated in the decline of rodents through direct predation, with the abundance of the Feral Cat found to be the best predictor of decline of all sized conilurine rodents where Red Foxes and European Rabbits are scarce or absent (Smith & Quinn 1996). The *Threat abatement plan for predation by Feral Cats* (2015) identifies the Hastings River Mouse as having a “high” threat rating from Feral Cat predation. The Hastings River Mouse is in the target weight range for vertebrate prey (under 220 g) and the potential consequence of predation over its range are considered to be of high enough severity (Department of the Environment 2015). Feral Cats are predominantly nocturnal and active at the same time as the Hastings River Mouse (Department of the Environment 2015). Feral Cat scat has been collected in the vicinity of the Hastings River Mouse sites but no remains have been identified in them (Pyke & Read 2002). Meek (2002), cited in NSW DECC (2005), recorded one potential Feral Cat predation event. However, Meek & Shield (2005) state that there is limited evidence that Feral Cats impact on the Hastings River Mouse.

			Feral Cats are associated with severe declines in species with low reproductive rates and where habitat may have been modified by grazing or frequent burning (Smith & Quinn 1996). Threat from predation could therefore increase where there is excessive grazing or burning that reduces ground cover or shelter sites (Law et al. 2016).

Assessment of available information in relation to the EPBC Act Criteria and Regulations

Criterion 1. Population size reduction (reduction in total numbers)
Population reduction (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 followin

(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

Evidence:

The generation length of the Hastings River Mouse is estimated to be two years (Townley 2000 cited in NSW DECC 2005), giving a six year time scale for this criterion (three generations).

The results of surveys of Hastings River Mouse populations undertaken to date are highly variable. Pyke & Read (2002) report that most populations appear to be very small (less than 10 individuals) and the apparent disappearance of the Hastings River Mouse from five previously known sites over a 15 year period. Until the turn of the century only 400 individuals had been caught (Fox et al. 1994; Pyke & Read 2002) and non-targeted mammal surveys have very rarely captured the Hastings River Mouse. This indicates that across the broad landscape, the Hastings River Mouse is very rare and highly localised (Pyke & Read 2002).

However, Meek & Shield (2005) report an increasing number of individuals being detected, giving the impression than the population is healthier than previously believed. This trend is supported by reports of trappings made to the Commonwealth Department of the Environment and Energy, where 74 trapping locations have been provided between 2010 and 2017. Meek (2003) suggests that low capture numbers may be due to poor targeting of historical surveys,

being limited to habitat associated with riparian features and the sub-optimal placement of traps (away from logs and rocks). In addition, trapping may have occurred at a disadvantageous seral stage in the ecological succession cycle (Meek & Shields 2005). Surveys focusing on trap placement near logs and rocks have enjoyed greater trapping success (Meek 2002; Meek et al. 2002; Meek 2003), with several larger populations being recently reported (Meek et al. 2003; Rowe et al., 2011). Meek et al. (2006) observed swift occupation of newly created territories by the Hastings River Mouse in the Marengo State Forest, indicating that this population was healthy and capable of recruitment and immigration. Where present, estimates indicate that the Hastings River Mouse occurs at a density similar to other small native mammal species (Pyke & Read 2002).

A decline in the Hastings River Mouse population overall is suspected but it is not possible to determine a trend in population size for the species from these data.

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

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 indicating distribution is precarious for survival:			
(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			

Evidence:

The Extent of Occurrence (EOO) is estimated at 83,266 km^2, and the Area of Occupancy (AOO) estimated at 504 km^2. These figures are based on the mapping of point records from 1997 to 2017, obtained from state governments, museums and CSIRO. The EOO was calculated using a minimum convex hull, and the AOO calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines 2014 (DotE 2015).

There are well known populations of the Hastings River Mouse in New South Wales around Mount Royal, Carrai Plateau, the Styx River, Gibraltar Range, Washpool National Park and Marengo State Forests. In Queensland, established populations are known in Lamington National Park and Gambubal State Forest (Meek et al. 2003; NSW DECC 2005; Rowe et al. 2011). However, populations are considered to be severely fragmented (Jerry et al. 1998; Rowe et al. 2011).

Meek (2004) predicted that the species is likely to decline further if disturbance is not explicitly incorporated into management to redress a decline in area or quality of habitat, with the specific conditions at a site being as or more important than geographical location in determining suitability and presence of the Hastings River Mouse (Graham et al. 2005). Continued habitat degradation can be inferred from the ongoing uncertainty in regards to the ecology of the species and the subsequent effectiveness of the measures implemented to manage its

recovery. An appropriate disturbance regime has not been qualified by research and current measures are suspected to encourage late seral stage interspecific competition (Law et al. 2016).

The data presented above appear to demonstrate that the species is **eligible for listing as Vulnerable (B2(a)(b)(iii))** under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

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

Evidence:

There is no reliable estimate of population size for this species. Woinarski et al. (2014) estimated the population to be under 10 000 individuals, with a continuing decline, and the largest subpopulation with less than 1000 individuals.

However, the Hastings River Mouse may occur across a wider range of habitat than considered previously, with individuals trapped across a wider range of topography, including habitat types outside of old growth forest and in habitat previously considered "unsuitable" (Meek 2003; Meek et al. 2003; Tasker & Dickman 2004; Graham et al. 2005; Meek et al. 2006).

Low capture numbers may be due to historical surveys being limited to habitat associated with riparian features and with sub-optimal placement of traps (away from logs and rocks) or occurring at a disadvantageous seral stage in the ecological succession cycle (Meek 2003; Meek & Shields 2005). Surveys focusing on trap placement near logs and rocks have enjoyed greater trapping success (Meek 2002; Meek et al. 2002; Meek 2003), with several larger populations being more recently reported (Meek et al. 2003; Rowe et al., 2011). Meek et al. (2006) observed swift occupation of newly created territories by the Hastings River Mouse in the Marengo State Forest, indicating that this population was healthy and capable of recruitment and immigration. Where present estimates indicate that the Hastings River Mouse occurs at a density similar to other small native mammal species (Pyke & Read 2002).

The data presented above appear to be insufficient to demonstrate if the species is eligible for listing under this criterion. However, the purpose of this consultation document is to elicit

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

Criterion 4. Number of mature individuals	Critically Endangered Extremely low	Endangered Very Low	Vulnerable Low
Number of mature individuals	**< 50**	**< 250**	**< 1,000**
D2[1] Only applies to the Vulnerable category Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time	**-**	**-**	**D2.** Typically: area of occupancy < 20 km² or number of locations ≤ 5

[1] The IUCN Red List Criterion D allows for species to be listed as Vulnerable under Criterion D2. The corresponding Criterion 4 in the EPBC Regulations does not currently include the provision for listing a species under D2. As such, a species cannot currently be listed under the EPBC Act under Criterion D2 only. However, assessments that demonstrate eligibility for listing under other criteria may include information relevant to D2. This information will not be considered by the Committee in making its assessment 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.

Evidence:

As described above under Criterion 3, the Committee considers that the population of Hastings River Mouse to be less than 10 000 individuals.

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**

Evidence:

Population viability analysis appears not to have been undertaken, there are insufficient data to demonstrate if the species is eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Conservation Actions

Recovery Plan

A recovery plan is in place for this species (NSW DECC 2005), it came into effect January 2008.

A decision about whether there should be a new 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.

Primary Conservation Actions

Use modern survey methods to better identify key populations of Hastings River Mouse and classify management units, particularly in areas of natural refuge and conservation tenure. Use data to improve distribution maps, knowledge on preferred habitat and investigate dispersal corridors.

Conservation Actions

Conservation and Management priorities

- Habitat loss disturbance and modifications
    - Designate protection zones around known populations to ensure habitat is not fragmented by roads, timber harvesting or clearing of freehold land. Activities permitted in protection zones should be dictated by further research into the effects of disturbance on the Hastings River Mouse.
- Invasive species (including threats from grazing, trampling, predation)
    - Develop and implement strategies to control predation by Red Foxes and Feral Cats, particularly in designated protection zones, as detailed in the Red Fox and Feral Cat Threat Abatement Plans (DEWHA 2008; Department of Environment 2015).
- Fire
    - Implement appropriate fire regimes as determined by further research.

Stakeholder Engagement

- Develop greater awareness of the species and encourage stakeholders to report sightings.
- Develop guidelines for the conservation and management of Hastings River Mouse populations and habitat and provide them to stakeholders such as public authorities, land management agencies and private landholders.

Survey and Monitoring priorities

- Conduct further strategic surveys for Hastings River Mouse, including long term monitoring of well-known sites to ascertain whether the populations are stable, and re-survey old sites to ensure absences recorded are not temporal.
- Use the results of these surveys to examine population dynamics and determine whether populations persist at low abundance or are becoming locally extinct and re-occupied (metapopulation model).

Information and Research priorities

- Use data from any further survey and monitoring work to better understand the habitat requirements of the Hastings River Mouse and how the species responds to different fire regimes and disturbance by forestry.
- Conduct before and after habitat manipulation experiments, such as placement of hollow logs in historical sites and *Rattus* species removal.
- Develop and test burning regimes to maintain and enhance habitat quality.

Collective list of questions – your views

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/subspecies? If so, in what capacity?

PART 1 – INFORMATION TO ASSIST LISTING ASSESSMENT

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

Biological information

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

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

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

Population size

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

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

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

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

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

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

Level of your confidence in this estimate:

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

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

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

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

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

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

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

Evidence of total population size change

10. Are you able to provide an estimate of the total population size in 2008-2010 *(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:

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

    Level of your confidence in this estimate:

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

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

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

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

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

11. Are you able to comment on the extent of decline in the species/subspecies' total population size over the last approximately 10 years? Please provide justification for your response.

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

Decline estimated to be in the range of:

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

Level of your confidence in this estimated decline:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

    Level of your confidence in this estimated extent of occurrence

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

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

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

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

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

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

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

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

Level of your confidence in this estimated extent of occurrence:

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

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

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

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

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

SECTION F ARE YOU AWARE OF TRENDS IN THE TOTAL RANGE OF THE SPECIES? (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/subspecies in the future?

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PART 3 – ANY OTHER INFORMATION

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

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