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Notice of and reasons for the Final Determination

The NSW Threatened Species Scientific Committee, established under the *Biodiversity Conservation Act 2016* (the Act), has made a Final Determination to list the Broad-toothed Rat, *Mastacomys fuscus mordicus* Thomas, 1922 as an Endangered species in Part 2 of Schedule 1 of the Act and, as a consequence, to omit the listing of:

1. *Mastacomys fuscus* Thomas, 1882 Broad-toothed Rat in Part 3 Division 1 of Schedule 1 (Vulnerable species) of the Act; and

2. The population of *Mastacomys fuscus* Thomas, 1882 Broad-toothed Rat at Barrington Tops in the local government areas of Gloucester, Scone and Dungog in Part 2 Division 4 of Schedule 1 (Endangered species) of the Act, as provided for in clause 4.1(5)(a) of the *Biodiversity Conservation Regulation 2017*.

Listing of Endangered species is provided for by Part 4 of the Act.

The NSW Threatened Species Scientific Committee is satisfied that the Broad-toothed Rat, *Mastacomys fuscus mordicus* Thomas, 1922 has been duly assessed by the Commonwealth Threatened Species Scientific Committee under the Common Assessment Method, as provided by Section 4.14 of the Act. After due consideration of DCCEEW (2023), the NSW Threatened Species Scientific Committee has made a decision to list the species as Endangered.

Summary of Conservation Assessment

The Broad-toothed Rat, *Mastacomys fuscus mordicus* Thomas, 1922 was found to be Endangered in accordance with the following provisions in the *Biodiversity Conservation Regulation 2017*: Clause 4.2 (1)(b)(2)(b)(c)(e) because the species has undergone a large reduction in population size (exceeding 50% over 10 years) and further reduction is likely to occur. These reductions are inferred based on (i) extrapolated decreases in site occupancy from an index of abundance across repeatedly monitored localities, (ii) a decline in habitat quality caused by the extensive 2019/2020 bushfires and climate change (particularly increased frequency of drought and severe wildfire), and (iii) the adverse effects of feral herbivores and introduced predators.

The NSW Threatened Species Scientific Committee has found that:

1. The Broad-toothed Rat, *Mastacomys fuscus mordicus* Thomas, 1922 (family Muridae) has a broad face, short tail and stocky body. It has fine, dense fur, which is brown tinged with rufous above, merging to a paler grey underneath. The fur may have a green tinge due to the presence of algae. The ears are small and round with tufts of hair inside. The feet are brown above and below. The tail is lightly haired, dark above and becoming slightly lighter underneath. It has

characteristically large molars in a rounded head. It has a head and body length of 14–17 cm and a tail length of 10–13 cm (Happold 2008; Ingleby 2022).

2. The past distribution of *Mastacomys fuscus mordicus* is known from New South Wales, the Australian Capital Territory, Victoria and South Australia, with numerous subfossil deposits found that lie well outside its currently recognised distribution and habitat (VSAC 2012; Bilney 2014; Fusco *et al.* 2016; R. Bilney pers. comm. April 2022; McDowell *et al.* 2023). It is currently known to have a highly fragmented distribution; mainly within the alpine and sub-alpine regions of southeastern Australia (Green and Osborne 2003). Kosciuszko National Park is the stronghold of the subspecies within New South Wales (DPIE 2019), and the northernmost subpopulation occurs in Barrington Tops National Park, disjunct from other known occurrences.

3. Seebeck and Menkhorst (2000) noted that *Mastacomys fuscus mordicus* was generally rare and localised but may be locally common in appropriate habitat. The most plausible estimate for the number of mature individuals is unknown but declining. Data are lacking to clearly define the number of subpopulations across the range but there are 10–20 areas that are identified. In Victoria, the Dandenong Range subpopulation is possibly extirpated, and that at Wilsons Promontory is likely to become extirpated within the next 5–10 years (DCCEEW 2023). Thus, the trend in number of subpopulations is decreasing.

4. The Extent of Occurrence (EOO) for *Mastacomys fuscus mordicus* is estimated to be 52,290 – 60,149 km^2, based on a minimum convex polygon, the method of assessment recommended by IUCN (2022). The Area of Occupancy (AOO) is estimated to be 912–1,152 km^2, based on 2 km x 2 km grid cells, the scale recommended for assessing AOO by IUCN (2022). The estimates of EOO and AOO were calculated using records compiled from state governments, museums, research institutions and non-government organisations. The lower estimates were obtained when including only the records from a five-year period (2017–2022), while the higher estimates were obtained when including only the records from a 10-year period (2012–2022).

5. The habitat of *Mastacomys fuscus mordicus* includes alpine and subalpine heathlands, grassland adjacent to boulder outcrops, swamps, sedgelands, coastal grassy or shrubby dunes, and sometimes forests with grassy understories (Wallis *et al.* 1982; Green and Osborne 2003).

6. *Mastacomys fuscus mordicus* is now predominantly found on sites that have a cooler climate, significant annual rainfall (> 1000 mm), a plentiful supply of food and adequate vegetative cover (Green and Osborne 2003; VSAC 2012). Currently most such sites are at higher elevations (> 1500 m), although the subspecies is also found in some coastal and foothill areas (VSAC 2012; Shipway *et al.* 2020). Its climatic niche may be considerably broader than indicated by the areas currently occupied (McDowell *et al.* 2023). Many areas of apparently suitable habitat for *M. f. mordicus* are unoccupied (Green and Osborne 2003), suggesting

the subspecies may have limited ability to disperse across unfavourable habitat (O'Brien *et al.* 2008).

7. *Mastacomys fuscus mordicus* is a terrestrial and mostly nocturnal rodent. It is herbivorous, with grasses forming the major component of its diet (Carron *et al.* 1990). In summer it nests in burrows in the soil. In alpine areas in winter, it dens communally during the day in nests of shredded grass situated in dense undergrowth or under logs beneath the snow (Bubela and Happold 1993). In alpine and sub-alpine areas, it is active in the vegetation layer under snow cover (Happold 1998).

8. The home range size and social dispersion of *Mastacomys fuscus mordicus* varies seasonally, from approximately 0.1 ha to 0.3 ha. Breeding is seasonal, with females giving birth to one or two litters (of 1–4 young) per season, between October and March (Happold 1998; Green 2007). Sexual maturity is reached at 6−12 months (Happold 2008; Happold 2011) and longevity is estimated between two and three years (Happold 2011). Generation length is assumed to be one to two years (Woinarski *et al.* 2014).

9. The 2019/2020 bushfire events burnt a large area of Eastern Australia (100,000 km^2), overlapping *c.* 27% of the *Mastacomys fuscus mordicus* distribution (Legge *et al.* 2021), with declines in AOO due to loss of areas that burned (Walker *et al.* 2021; Macak and Rowe 2022; NSW DPE unpublished data). It is thus plausible that the subspecies' range comprises 5–10 threat-defined locations (per IUCN 2022).

10. *Mastacomys fuscus mordicus* falls within the Critical Weight Range (Burbidge and McKenzie 1989) of prey species typically targeted by the European Red Fox (*Vulpes vulpes*) and Feral Cat (*Felis catus*). Both of these predators have been found to specifically target *M. f. mordicus* over other rodent species in the same landscape (Green 2002; Schroder *et al.* in review). Predation by introduced predators has caused range and niche contraction for *M. f. mordicus* and continues to prevent niche expansion to areas that would otherwise be suitable (Bilney *et al.* 2010). 'Predation by the European Red Fox *Vulpes vulpes* (Linnaeus, 1758)' and 'Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)' are listed as Key Threatening Processes under the Act.

11. The immediate adverse effects of high-severity fire on subpopulations of *Mastacomys fuscus mordicus* are direct mortality and loss of resources (*e.g.,* food and shelter via reduced habitat extent and suitability) (Happold 2008; VSAC 2012; Woinarski and Burbidge 2016; Walker *et al.* 2021). Invasive predators often have increased activity and hunting success in burnt habitats, particularly following high severity fire (McGregor *et al.* 2016; Hradsky *et al.* 2017). In addition, local extirpation following high severity fire may fragment and isolate subpopulations, making them more susceptible to stochastic extinction events (Walker *et al.* 2021).

12. After burning, it may take a long time for vegetation to recover to a point where it is suitable for *Mastacomys fuscus mordicus* to recolonise (NSW DPE pers. comm.

April 2022). Macak and Rowe (2022) found sites burnt two to three times in the last 20 years were structurally similar to recently burnt sites (*i.e*., having a very sparse understorey and ground layer) and as such, were generally considered unsuitable for *M. f. mordicus.* This highlights the negative effect that frequent fires can have on *M. f. mordicus* habitat. 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' is listed as a Key Threatening Process under the Act.

13. Introduced herbivores alter the structure, composition and function of ecosystems, contributing significantly to erosion and to the establishment and spread of weeds. Feral Horses (*Equus caballus*) are currently the main threat to *Mastacomys fuscus mordicus* among the feral herbivores (Driscoll *et al.* 2019). There is also evidence of adverse effects from deer (*e.g.,* sambar, *Rusa unicolor*), cattle (*Bos taurus*), pigs (*Sus scrofa*), rabbits (*Oryctolagus cuniculus*) and hares (*Lepus europaeus*) (Woinarski and Burbidge 2016). Grazing and trampling of vegetation removes shelter, nesting habitat and food sources (Green and Osborne 2003; Belcher and Leslie 2011; Milner *et al.* 2015) and can prevent the regeneration of habitat after fire. 'Competition and grazing by the feral European Rabbit, *Oryctolagus cuniculus (L.)*'; 'Habitat degradation and loss by Feral Horses (brumbies, wild horses), *Equus caballus* Linnaeus 1758'; 'Herbivory and environmental degradation caused by feral deer'; and 'Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* Linnaeus 1758' are listed as Key Threatening Processes under the Act.

14. Climate change represents a significant and increasing threat to *Mastacomys fuscus mordicus* through its effects on increasing the frequency, intensity and scale of fire (Abram *et al.* 2021) and shifts in the composition and distribution of alpine vegetation communities (DECC 2007, Milner *et al.* 2015). Climate projections for southeastern Australia include reduced rainfall, increased average temperatures, and greater frequency of extreme droughts (CSIRO and Bureau of Meteorology 2015). With elevated summer temperatures, woody vegetation is likely to increase in alpine areas (Williams and Costin 1994), and drainage lines may dry, leading to an overall reduction in habitat complexity and structure. This may reduce optimal habitat for the subspecies given that proximity to drainage lines appears to be important, and they have shown a tendency to avoid woodland habitat (Milner *et al.* 2015). In addition, early snow thaws in the Snowy Mountains (NSW) were found to have detrimental impacts on subpopulations (Woinarski *et al.* 2014) with a population reduction of 25% associated with lack of snow cover in 1999, which would have increased susceptibility to predation by foxes (Green and Osborne 2012). 'Anthropogenic Climate Change' is listed as a Key Threatening Process under the Act.

15. A reduced occupancy of *Mastacomys fuscus mordicus* was recorded at ten of eleven localities where repeat surveys for this species have been conducted (over any period between 1979 and 2022, DCCEEW 2023). The reductions in occupancy across those localities ranged from 26–100% (DCCEEW 2023). When these occupancy changes are extrapolated to their equivalent changes from 2012–2022 based on the assumption of linear decline, the estimated overall reduction for the subspecies is 74% (DCCEEW 2023).

16. The Broad-toothed Rat, *Mastacomys fuscus mordicus* Thomas, 1922 is not eligible to be listed as a Critically Endangered species.

17. The Broad-toothed Rat, *Mastacomys fuscus mordicus* Thomas, 1922 is eligible to be listed as an Endangered species as, in the opinion of the NSW Threatened Species Scientific Committee, it is facing a very high risk of extinction in Australia in the near future as determined in accordance with the following criteria as prescribed by the *Biodiversity Conservation Regulation 2017*:

Assessment against *Biodiversity Conservation Regulation 2017* criteria
The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome: Endangered under Clause 4.2 (1)(b)(2)(b)(c)(e)

Clause 4.2 – Reduction in population size of species
(Equivalent to IUCN criterion A)
Assessment Outcome: Endangered under Clause 4.2 (1)(b)(2)(b)(c)(e)

(1) - The species has undergone or is likely to undergo within a time frame appropriate to the life cycle and habitat characteristics of the taxon:			
	(a)	for critically endangered species	a very large reduction in population size, or
	(b)	for endangered species	a large reduction in population size, or
	(c)	for vulnerable species	a moderate reduction in population size.
(2) - The determination of that criteria is to be based on any of the following:			
	(a)	direct observation,	
	(b)	an index of abundance appropriate to the taxon,	
	(c)	a decline in the geographic distribution or habitat quality,	
	(d)	the actual or potential levels of exploitation of the species,	
	(e)	the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.	

Clause 4.3 – Restricted geographic distribution of species and other conditions
(Equivalent to IUCN criterion B)
Assessment Outcome: Vulnerable under Clause 4.3 (c)(d)(e i, ii, iii, iv)

The geographic distribution of the species is:			
	(a)	for critically endangered species	very highly restricted, or
	(b)	for endangered species	highly restricted, or
	(c)	for vulnerable species	moderately restricted.
and at least 2 of the following 3 conditions apply:			
	(d)	the population or habitat of the species is severely fragmented or nearly all the mature individuals of the species occur within a small number of locations,	
	(e)	there is a projected or continuing decline in any of the following:	
		(i)	an index of abundance appropriate to the taxon,

		(ii)	the geographic distribution of the species,
		(iii)	habitat area, extent or quality,
		(iv)	the number of locations in which the species occurs or of populations of the species.
	(f)	extreme fluctuations occur in any of the following:	
		(i)	an index of abundance appropriate to the taxon,
		(ii)	the geographic distribution of the species,
		(iii)	the number of locations in which the species occur or of populations of the species.

Clause 4.4 – Low numbers of mature individuals of species and other conditions
(Equivalent to IUCN criterion Clause C)
Assessment Outcome: Data Deficient

The estimated total number of mature individuals of the species is:						
	(a)	for critically endangered species				very low, or
	(b)	for endangered species				low, or
	(c)	for vulnerable species				moderately low.
and either of the following 2 conditions apply:						
	(d)	a continuing decline in the number of mature individuals that is (according to an index of abundance appropriate to the species):				
		(i)	for critically endangered species			very large, or
		(ii)	for endangered species			large, or
		(iii)	for vulnerable species			moderate,
	(e)	both of the following apply:				
		(i)	a continuing decline in the number of mature individuals (according to an index of abundance appropriate to the species), and			
		(ii)	at least one of the following applies:			
			(A)	the number of individuals in each population of the species is:		
				(I)	for critically endangered species	extremely low, or
				(II)	for endangered species	very low, or
				(III)	for vulnerable species	low,
			(B)	all or nearly all mature individuals of the species occur within one population,		
			(C)	extreme fluctuations occur in an index of abundance appropriate to the species.		

Clause 4.5 – Low total numbers of mature individuals of species
(Equivalent to IUCN criterion D)
Assessment Outcome: Data Deficient

The total number of mature individuals of the species is:			
	(a)	for critically endangered species	extremely low, or
	(b)	for endangered species	very low, or
	(c)	for vulnerable species	low.

Clause 4.6 – Quantitative analysis of extinction probability
(Equivalent to IUCN criterion E)
Assessment Outcome: Data Deficient

The probability of extinction of the species is estimated to be:			
	(a)	for critically endangered species	extremely high, or
	(b)	for endangered species	very high, or
	(c)	for vulnerable species	high.

Clause 4.7 – Very highly restricted geographic distribution of species– vulnerable species
(Equivalent to IUCN criterion D2)
Assessment Outcome: Not met.

For vulnerable species,	the geographic distribution of the species or the number of locations of the species is very highly restricted such that the species is prone to the effects of human activities or stochastic events within a very short time period.

Senior Professor Kristine French
Chairperson
NSW Threatened Species Scientific Committee

Supporting Documentation:

DCCEEW (Department of Climate Change, Energy, the Environment and Water) (2023). Conservation Advice for *Mastacomys fuscus mordicus* (Broad-toothed Rat (Mainland)). Australian Government, Canberra, ACT.

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