

THREATENED SPECIES SCIENTIFIC COMMITTEE

Established under the *Environment Protection and Biodiversity Conservation Act 1999*

The Minister approved this conservation advice on 5 May 2016; and confirmed this subspecies 4 Apr 2001 inclusion in the Endangered category.

Conservation Advice

Isoodon obesulus obesulus

southern brown bandicoot (eastern)

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 are 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

Paull (2008) recognised three subspecies of southern brown bandicoot in the south-eastern states: *I. o. obesulus* (New South Wales (NSW), Victoria and South Australia), *I. o. nauticus* (Nuyts Archipelago, South Australia) and *I. o. affinis* (Tasmania).

Following Pope et al. (2001), Zenger et al. (2005) and Westerman et al. (2012), Woinarski et al. (2014) included *I. o. affinis* and *I. o. nauticus* as part of *I. o. obesulus*. This taxonomic grouping was accepted by the Australian Faunal Directory, and contributed to the re-evaluation of the status of *I. o. obesulus* undertaken here.

However, recent genetic analysis suggests that *I. o. affinis* is genetically distinct from the mainland populations (Cooper et al., unpublished). Results from other research also indicate that individuals in NSW, Victoria and south-east South Australia (Mt Burr Range) are genetically distinct from individuals west of the Murray River (Li et al., 2014a). Jackson & Groves (2015) retain *I. o. affinis* and *I. o. nauticus* as distinct subspecies, and consider *I. o. obesulus* to include all South Australian populations other than those on the Nuyts Archipelago.

Genetic work on *Isoodon obesulus* is ongoing and the taxonomy remains unresolved. For the purposes of this assessment the *I. o. obesulus* populations within NSW, Victoria and South Australia, excluding Nuyts Archipelago, are considered to form a single taxonomic entity.

Summary of assessment

Conservation status

Endangered: Criterion 1 A2(a)(c)(e)

The highest category for which *Isoodon obesulus obesulus* is eligible to be listed is Endangered.

Isoodon obesulus obesulus has been found to be eligible for listing under the following listing categories:

Criterion 1: A2(a)(c)(e): Endangered

Criterion 2: B1, B2 (a),(b)(i-v): Vulnerable

Species can be listed as threatened under state and territory legislation. For information on the listing status of this species under relevant state or territory legislation, see <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>.

Reason for conservation assessment by the Threatened Species Scientific Committee

This advice follows assessment of new information provided to the Committee to re-assess the listing status of *Isoodon obesulus obesulus*, which was listed under the EPBC Act in the Endangered category in 2001.

Public Consultation

Notice of the proposed amendment and a consultation document was made available for public comment for 49 business days between 17 December 2014 and 27 February 2015. Any comments received that were relevant to the survival of *Isoodon obesulus obesulus* were considered by the Committee as part of the assessment process.

Species/Subspecies Information

Description

The southern brown bandicoot, family *Peramelidae*, is a medium-sized, ground-dwelling marsupial with a head and body length of approximately 30 cm (NSW DEC 2006; Paull 2008). Like other members of the family, the southern brown bandicoot has a long tapering snout, a naked nose, a compact body (NSW DEC 2006) and a short tail generally 110–120 mm long (Paull 2008). The head has small, rounded ears and small, black eyes (NSW DEC 2006; Paull 2008). The dorsal surface of the body bears black spiny bristle-hairs and softer, dark grey underfur that appears brown at a distance (Paull 2008). The softer underbelly is creamy-white (NSW DEC 2006). While the forelegs are short with curved claws on the digits, the hind limbs are much longer, resembling those of macropods (NSW DEC 2006). Males are heavier (mean weight 890 g) than females (mean weight 620 g) (Paull 2008).

Distribution

The southern brown bandicoot has experienced severe range contractions and population declines since European settlement (Zenger et al., 2005; Bilney et al., 2010). Maxwell et al. (1996) estimate that the southern brown bandicoot (eastern) has experienced a 50–90 percent decline in its range. Its distribution is now highly fragmented with many discontinuous subpopulations (Paull 2003; Zenger et al., 2005; Le Duff & Stratman 2009).

The distribution of the southern brown bandicoot (eastern) extends from the southern side of the Hawkesbury River in New South Wales to Kangaroo Island in South Australia. Within this range it occurs mostly in coastal areas (Woinarski et al., 2014). In NSW there are two population strongholds: Ku-ring-gai Chase and Garigal National Parks just north of Sydney, and the far south-east corner (including Ben Boyd National Park, East Boyd State Forest, Nadgee Nature Reserve, Nadgee State Forest, South East Forest National Park and Yambulla State Forest) (NSW DEC 2006). In Victoria records are clustered within several bioregions, including: the East Gippsland Lowlands, Gippsland Plain (Western section), Otway Plain (Anglesea section), Warrnambool Plain (Port Campbell section), Greater Grampians, Glenelg Plains and Wilsons Promontory (Coates et al., 2008). In South Australia it occurs along the coastline of the state's south-east corner (particularly the Mt Burr Range), in the Mt Lofty Ranges east of Adelaide, Fleurieu Peninsula and Kangaroo Island.

Relevant Biology/Ecology

The southern brown bandicoot inhabits areas of dense vegetation, including wetland fringes and heathland (Paull 2008). It has been observed in both native bushland and areas with exotic shrubby species such as blackberry (*Rubus* spp.) (Packer 2013). Bandicoots are secretive and rarely venture far from cover, possibly to avoid predation (Claridge 1998).

The species is omnivorous and forages for food mainly by digging in the leaf litter and soil to find insects, fungi, plant root nodules and bulbs. It also eats fruit, seeds and other plant material found above ground. Bandicoots construct nests under plants on the ground; they do not create their own burrow, but occasionally use the burrows of other species (Paull 2008).

The southern brown bandicoot breeds throughout the year with a peak in spring. The backward opening pouch contains eight teats arranged in an incomplete circle, and accommodates one to six (usually two to four) young in a litter (Woinarski et al., 2014). A study in the Mount Lofty Ranges found that litter size was 1–4 with an average of two pouch young per litter (Packer 2013). Two or three litters may be reared in a year, although this is dependent upon food availability (Woinarski et al., 2014).

Despite high fecundity rates, relatively low juvenile survival rates have been recorded at some sites, with mortality rates of 50 percent recorded between the ages of birth and independence (Paull 1992). In the Mount Lofty Ranges, survival and recruitment of young in native remnants were found to be low (Packer 2013).

Sexual maturity is reached in about 60 days. Longevity in the wild is three to four years (Paull 2008), although in captivity animals have survived for up to six years (AnAge 2012). Generation time is taken to be two years (Woinarski et al., 2014).

Based on capture rate data in Victoria and South Australia, all populations (except those in fenced reserves) appear to occur at low to very low densities throughout most of the species' range (Coates & Wright 2003; SA DEWNR 2015). However, densities vary depending on resource availability (Packer 2013). Home ranges are typically between 0.5 ha and 5 ha (i.e. densities of 20–200 individuals/km²), assuming no overlap in home range (Paull 2008), but are strongly influenced by seasonal conditions (Vic DELWP 2015).

Threats

The major threats to the southern brown bandicoot (eastern) are predation by foxes (*Vulpes vulpes*) and cats (*Felis catus*), habitat loss and degradation, and too frequent and extensive burning. Several fox control programs are currently undertaken by state governments, and populations have responded well to these programs in some areas (Morris et al., 1998; Vic DELWP 2015). However, fox baiting has not been universally successful. In northern Sydney the bandicoot population appears to be in decline despite the area being subjected to fox baiting since 2000 (NSW OEH 2015). In western Victoria, following an initial increase in numbers following fox removal, occupancy rates declined, indicating that other limiting factors are affecting populations and preventing their recovery (Vic DELWP 2015) such as food availability, habitat quality and feral cats (Robley et al., 2014). Monitoring responses to fox control has also been difficult due to a lack of pre-fox control data (Murray pers. comm., 2015).

Threats to the southern brown bandicoot (eastern) may interact. Populations increase with increasing time since fire and increased density of ground cover (Claridge & Barry 2000); data suggests that burnt areas in the Mt Lofty ranges have insufficient vegetation density to sustain bandicoot populations for at least four years post-fire, depending on the habitat type (SA DEWNR 2015). The impact of predation (mainly by foxes and cats) can be severe post-fire, with additional evidence of dog predation (SA DEWNR 2015), although the impacts of feral (and stray) dogs are not well understood.

Habitat degradation due to weed infestation is a complex issue in some areas of South Australia. Much of the habitat in the Mt Lofty Ranges is degraded through the occurrence of environmental weeds, notably blackberry (*Rubus* spp.), broom (*Cytisus* spp.) and gorse (*Ulex* spp.). Landholders and land managers have a legal responsibility to control plants recognised as weeds under legislation, however, these plants provide habitat for bandicoots and there are anecdotal reports of bandicoot populations disappearing following broad-scale weed control (Long pers. comm., 2009, cited in Brown & Main 2010). The removal of blackberry has altered the home ranges of bandicoots in the Adelaide Hills, while the removal of introduced heath (*Erica* spp.) probably led to a localised decline in bandicoot numbers (Reese 2000, cited in Brown & Main 2010).

A list of threats is outlined in the table below.

Threat factor	Consequence rating	Extent over which threat may operate	Evidence base
Predation by foxes	Severe	Large	Strong evidence (e.g. Coates & Wright 2003). However, some populations manage to survive in the presence of foxes (Mussared pers. comm., 2015).
Habitat loss and fragmentation	Severe	Large	Demonstrated absence or reduced abundance in cleared areas (Lunney & Leary 1988). Habitat in South Australia is highly fragmented (Li et al., 2014a) and genetic data suggests this may be limiting the bandicoot's ability to disperse (SA DEWNR 2015). However, many of the remnant populations in central southern Victoria are in areas of rank grass and weeds such as gorse.
Predation by feral and domestic cats	Moderate-severe	Large	Cats take juvenile bandicoots. Bandicoot populations do not seem to survive persistent predation by cats (Mussared pers. comm., 2015). Impacts of feral (and stray) dogs are less well understood; however, bandicoots can survive in their presence, e.g. in Koo Wee Rup town.
Too frequent and extensive burning	Moderate-severe	Moderate-large	Populations are highly fragmented and vulnerable to extirpation by fire. Evidence that populations increase with increasing time since fire and increased density of ground cover (Claridge & Barry 2000). Wildfire and fuel reduction burning in southern Australia has become more frequent, intense and widespread (Gaborov pers. comm., 2015). There is increased pressure to undertake prescribed burning programs across 5% of high risk land (SA DEWNR 2014). Evidence that impacts of predation (mainly by foxes and cats) can be severe post-fire (SA DEWNR 2015).
Mortalities associated with road traffic	Moderate	Minor	Road kills have been observed.
Habitat change due to livestock and other non-native herbivores	Moderate	Minor	There is some correlative evidence.
Climate change	Moderate	Large	Risks to southern brown bandicoot habitat are outlined in Brereton et al. (1995). Climate change models for the Adelaide and Mount Lofty Ranges show an overall increase in temperature and a decrease in the average annual rainfall over the next four decades; this will have adverse effects on habitat quality and could lead to further

			local extinctions (Nature Conservation Society of South Australia 2015).
Displacement by high densities of rabbits	Moderate	Large	Some evidence in Victoria (Legg pers. comm., 2015).
Disease	Moderate	Large	Toxoplasmosis is known in some bandicoot populations; the eastern barred bandicoot is susceptible to toxoplasmosis contracted through consumption of infected worms (Silvana et al., 2000). However, impacts on the southern brown bandicoot are poorly understood.
Timber harvesting	Moderate	Moderate	Impacts vary depending on the forest management regime and the age of regrowth (Brown & Main 2010). Impacts are large in south-east NSW.
Reduced genetic diversity	Minor	Minor	There is significant population genetic structuring at a fine spatial scale in the Mt Burr region, most likely due to habitat fragmentation (Li et al., 2014b). This may also be the case in the Mt Lofty Ranges and other highly fragmented areas within the bandicoot's distribution.
Habitat change due to weed infestation	Minor	Minor	There is some evidence of case-by-case detriment provided by weeds. Broad-scale weed control has reduced the abundance of bandicoots in some areas (Long pers. comm., 2009, Reese 2000; both cited in Brown & Main 2010).
Habitat change due to <i>Phytophthora</i> infestation	Moderate	Minor	There is evidence of impacts on the diversity and abundance of small mammals (Laidlaw & Wilson 2006).
Poisoning associated with control of non-native predators	Minor	Minor	There is some evidence of consumption of rat poison (Davies pers. comm., 2015).

How judged by the Committee 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	<p>Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.</p> <p>(a) direct observation [except A3]</p>		
A2			
A3			
A4			
		<p>based on any of the following:</p> <p>(b) an index of abundance appropriate to the taxon</p> <p>(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat</p> <p>(d) actual or potential levels of exploitation</p> <p>(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites</p>	

Evidence:

Eligible for listing as Endangered under Criterion 1 A2 (a)(c)(e)

The southern brown bandicoot (eastern) has historically suffered large population declines. Formerly extremely abundant across much of its range, many subpopulations have disappeared and it is now uncommon in many remaining areas (Lunney & Leary 1988). While there are no robust estimates of overall population size in NSW, Victoria or South Australia due to a lack of sufficient survey effort and/or longitudinal data across its distribution (Vic DELWP 2015; NSW OEH 2015; SA DEWNR 2015), continuing declines have been reported in many areas across the subspecies' range.

In NSW the southern brown bandicoot's (eastern) geographic distribution has possibly declined in the past 10 years (NSW OEH 2015). In northern Sydney, where monitoring using mark-recapture methods has been ongoing since 2000, populations were relatively stable until 2008; however, more recently there have been population declines with local (potentially temporary) extinctions following fire events (NSW OEH 2015). This area has also been subject to fox baiting since 2000, but this has been insufficient to prevent further decline (NSW OEH 2015). Bandicoots in the north of their range in NSW appear to be under more pressure than those of southern NSW, due to more intensive habitat fragmentation exacerbating other threats (NSW OEH 2015).

In southern NSW trapping efforts have been limited in scale and few individuals have ever been captured. Trapping in Ben Boyd National Park and Nadgee Nature Reserve from 2000 to 2004 yielded only three captures, despite 300 trap nights per reserve per year (NSW OEH 2015). Activity monitoring using sand traps recorded declines in bandicoots (species unable to be determined) in the same reserves from 1999 to 2008. The overall decline was 44 percent in Ben Boyd National Park and 47 percent in Nadgee, and occurred despite a substantial decline in fox activity due to 1080 baiting in Ben Boyd National Park (Claridge et al., 2010).

In Victoria populations are continuing to decline at a variety of sites (Vic DELWP 2015). There is evidence of declines in the past 10 years in south-east Melbourne, west Gippsland, Mornington Peninsula and Western Port (McNaught pers. comm., 2015; Cardinia Shire Council 2015; Anderson pers. comm., 2015; Legg pers. comm., 2015; Nicholls pers. comm., 2015). At Port Campbell the population has declined by greater than 70 percent over the last 8 years, and is continuing to decline at a rate of greater than 10 percent per year (Port Campbell Community Group 2015). An important population at Pines Flora and Fauna Reserve, Frankston, is now presumed extinct with the last individual sighted in 2006 (Coates pers comm., 2015b). Very large wildfires over the past 10 years have significantly impacted on the extent and quality of available habitat in some areas (e.g. the Grampians, Wilsons Promontory, Gippsland), and by inference on the size and viability of populations in these areas (Vic DELWP 2015). Impacts of wildfires on the Grampians have resulted in less than 10 percent of the habitat being older than 10 years, and drought conditions have limited regrowth (Vic DELWP 2015); this has likely impacted on recovery as small mammal recovery post-fire is linked to vegetation structure and food resource availability (Monamy & Fox 2000; Arthur et al., 2012).

Responses of the southern brown bandicoot (eastern) to fox control programs in Victoria have been varied. In east Gippsland, where the Southern Ark fox control program has been operating, there has been a recovery of the population (Vic DELWP 2015). However, in the Glenelg Ark treatment area in south-western Victoria where populations have been monitored since 2005, populations initially increased but started to decline after 2008, and by 2012 were lower at treated sites than at non-treated sites (Vic DELWP 2015; Robley et al., 2014). This decline may be due to increased predation by feral cats facilitated by the reduction in fox numbers, with data from trapping and cameras suggesting cat densities were three times higher within fox treatment areas (Robley et al., 2014; Vic DELWP 2015). In the Grampians, under the Grampians Ark program, populations initially increased (Homan & Schultz 2012) but have declined since 2012 (Vic DELWP 2015).

A review of available data and anecdotal information by the Southern Brown Bandicoot Regional Recovery Group found that all populations in Victoria have remained stable or declined, and that high quality reserves continue to have very low numbers (Nicholls pers. comm., 2015).

In South Australia monitoring conducted in 1998 and again in 2009 in the south-eastern regions indicated that, overall, the area of occupancy and extent of occurrence for the southern brown bandicoot (eastern) was relatively stable over this period (SA DEWNR 2015). However, there has been a definite decline in numbers in some areas and the population is highly fragmented (SA DEWNR 2015).

The geographic distribution of the subspecies in the Mt Lofty Ranges has declined over the past 5–10 years. Previously, five metapopulations were identified in the area (SA DEWNR 2015). However, repeated surveys in the northernmost metapopulation (Parra Wirra/Warren native vegetation complex) using a variety of techniques have failed to detect bandicoots since 2009 at sites where they were historically recorded (SA DEWNR 2015). Surveys in 2012 and 2014 revealed declines in other metapopulations such as the Cox Scrub native vegetation complex, where camera trapping and surveys of diggings failed to detect bandicoots at most sites where they were previously recorded (SA DEWNR 2015).

Surveys on Kangaroo Island in 2008 suggest that the subspecies is widespread on the island, but trends in distribution are unclear (SA DEWNR 2015). Across South Australia, survey effort has not been adequate to determine total adult population size or population trends (SA DEWNR 2015).

Available quantitative data are summarised in the table below.

Population	State	Decline
Ben Boyd National Park	NSW	44% (1999 to 2008)
Nadgee Nature Reserve	NSW	47% (1999 to 2008)
Port Campbell	Vic	>70% (past 10 years)
Pines Flora and Fauna Reserve	Vic	100% (extirpated around 2006)
Mt Lofty Ranges – northern metapopulation	SA	100% (extirpated around 2009)

Following assessment of the information, the Committee considers that the southern brown bandicoot (eastern) is continuing to decline across its range. Existing habitat fragmentation exacerbates threats continuing to operate over much of its range, particularly predation by foxes and feral cats, too frequent and extensive burning, and further habitat clearing and fragmentation. All of the available quantitative estimates for recent population trends exceed or approach a 50 percent reduction in numbers over a recent 10 year period (see table above). For many populations that lack quantitative estimates, there is qualitative evidence of recent population decline. This information, combined with current understanding of ongoing threats listed above (as well as extensive wildfires in the Grampians over the past 10 years resulting in large impacts on habitat), suggests that the southern brown bandicoot (eastern) has likely undergone a severe reduction in numbers of at least 50 percent over the past 10 years, and the causes have not ceased and are not well understood. Therefore, the southern brown bandicoot (eastern) has met the relevant elements of Criterion 1 to make it eligible for listing as Endangered.

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 km ²	< 5,000 km ²	< 20,000 km ²
B2. Area of occupancy (AOO)	< 10 km ²	< 500 km ²	< 2,000 km ²
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			

Evidence:

Eligible for listing as Vulnerable under Criterion 2 B1, B2 (a),(b)(i-v)

The extent of occurrence for the southern brown bandicoot (eastern) is estimated at 13 718 km², and the area of occupancy estimated at 1900 km². These figures are based on the mapping of point records from 1995 to 2015, 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). When point records from 1980 to 2015 are mapped the EOO is 18 925 km² and the AOO 2896 km², which equates to a decline in the AOO by approximately 34% between 1980 and 1995 (see table below).

The data suggest that the EOO has also declined between 1980 and 1995. However, figures showing the extent of change in the EOO have a larger degree of uncertainty and are therefore not presented here (DotE 2015a).

	AOO (km ²) using records post-1980	AOO (km ²) using records post-1995	Change in AOO between 1980 and 1995
New South Wales	448	276	-38%
Victoria	1312	848	-35%
South Australia	1136	776	-32%
Total	2896	1900	-34%

The above data support anecdotal evidence which suggests that the AOO in Victoria is declining due to encroaching development and habitat loss (Frankston City Council 2015). Surveys in south-western Victoria have also shown large areas of apparently suitable habitat to be unoccupied (Brown & Main 2010). The bandicoot's distribution is highly fragmented (Paull 2003; Zenger et al., 2005; Le Duff & Stratman 2009), and there have been observed continuing declines in population numbers, area of occupancy and number of subpopulations (see Criterion 1).

In South Australia, the bandicoot has a severely fragmented distribution and there has been an observed continuing decline in the extent of occurrence, area of occupancy, area and quality of habitat, and number of locations (SA DEWNR 2015). This declining trend is most evident in the Mt Lofty Ranges, where the bandicoot's geographic distribution has declined over the past 5–10 years (see Criterion 1).

The Committee considers that the bandicoot's extent of occurrence and area of occupancy are limited, and the geographic distribution is precarious for its survival because it is severely fragmented and a decline in extent of occurrence, area of occupancy, habitat, number of individuals and number of locations may be inferred or projected. Therefore, the southern brown bandicoot (eastern) has met the relevant elements of Criterion 2 to make it eligible for listing as Vulnerable.

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
(a) (ii) % of mature individuals in one subpopulation =	90 – 100%	95 – 100%	100%
(b) Extreme fluctuations in the number of mature individuals			

Evidence:

Not eligible

Survey and monitoring effort have not been adequate to enable a robust estimate of population size for the southern brown bandicoot (eastern). Few rigorous monitoring programs are in place, and many records are old with individuals no longer occurring at many sites where they were previously recorded (Coates pers. comm., 2015a; SA DEWNR 2015; Murray pers. comm., 2015; Legg pers. comm., 2015). Although population estimates exist for some sites, few of these are reliable and contemporary, and many sites have very low trapping rates or other indicators of density (Coates pers comm., 2015a). In the south-east of NSW, for example, home range sizes are unknown and the relationship between detection and population density is poorly understood (NSW OEH 2015). Many monitoring programs focus on trends in detection levels only, rather than using techniques that could provide population estimates (NSW OEH 2015).

In northern Sydney, NSW, the population is estimated to be between 54 and 900 individuals, based on available habitat, occupancy rates and home range size. However, these estimates are based on studies in which trapping rates were higher than is currently the case, and thus may be overestimates (NSW OEH 2015). In southern NSW, there is no information about home range sizes in the region that could be used to extrapolate across potential habitat and estimate potential population size, and few individuals have ever been captured. However, the spatial extent of recent records is approximately twice that of the northern NSW population, so it is speculated that the adult population size exceeds that predicated for the northern NSW population, but by how much is unknown (NSW OEH 2015).

In Victoria, population estimates in different parts of the state vary, from between 14 700 and 264 000 individuals in East Gippsland (based on home range sizes of 0.5–9 ha, likely habitat of 132 000 ha, and assuming presence of fox control undertaken by the Southern Ark project) (Murray pers. comm., 2015), to the “very low hundreds” in Western Port, to the “very low thousands” in the region from Wilsons Promontory to Melbourne (Nicholls pers. comm., 2015). It is possible that the Victorian population could be less than 10 000 mature individuals (Nicholls pers. comm., 2015).

In South Australia, survey effort within has not been adequate to determine adult population size (SA DEWNR 2015). Bandicoots are difficult to survey and bandicoot activity is very variable (Mussared pers. comm., 2015). Bandicoot density varies considerably with resource availability (Packer 2013), and populations in South Australia are patchily distributed across a fragmented landscape (Li et al., 2014a).

Following assessment of the data, the Committee considers that the total number of mature individuals is likely to be greater than 10 000. Therefore, the southern brown bandicoot (eastern) has not met this required element of this criterion.

Criterion 4. Number of mature individuals			
	Critically Endangered Extremely low	Endangered Very Low	Vulnerable Low
Number of mature individuals	< 50	< 250	< 1,000

Evidence:

Not eligible

There is no robust estimate of population size for the southern brown bandicoot (eastern). However, based on the available data (see Criterion 3), the total number of mature individuals is highly likely to be greater than 1000.

Following assessment of the data the Committee considers that the total number of mature individuals is not extremely low, very low or low. Therefore, the southern brown bandicoot (eastern) has not met this required element of this criterion.

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:

Insufficient data to determine eligibility

A population viability analysis undertaken for the greater Melbourne region, which included populations around Cardinia, Casey, Frankston, and the northern Mornington Peninsula, indicated that 84 percent of populations in the region would go extinct in 100 years without active management (Lechner 2006).

However, a population viability analysis for the total population has not been undertaken. The Committee considers that there is insufficient information to determine the eligibility of the species for listing in any category under this criterion.

Conservation Actions

Recovery Plan

The Committee recommends that there should be a recovery plan for *Isoodon obesulus obesulus* (southern brown bandicoot (eastern)), as existing mechanisms are not adequate to stop its decline and support recovery. Populations are continuing to decline despite the southern brown bandicoot (eastern) being listed as threatened under the EPBC Act since 2001. The populations have a fragmented distribution which spans three states, and a coordinated management and monitoring program is required to ensure survival of the remaining populations. While some of its habitat lies in protected areas, including some EPBC Act listed threatened ecological communities (TSSC 2014), these areas are still exposed to predation by foxes and much of the remainder of its habitat overlaps with development.

A draft national recovery plan for the southern brown bandicoot (eastern) has been prepared by the Victorian Department of Sustainability and Environment (Brown & Main 2010), but has not yet been finalised or adopted under the EPBC Act. There is existing Conservation Advice under the EPBC Act, which identifies regional and local priority recovery and threat abatement actions to support the recovery of the southern brown bandicoot (eastern) (TSSC 2014).

A number of other plans/strategies have been developed that assist in protecting the southern brown bandicoot (eastern), including:

- Southern brown bandicoot (*Isoodon obesulus*) recovery plan (NSW DEC 2006)
- Sub-regional species strategy for the southern brown bandicoot (Vic DEPI 2014)
- Recovery plan for the southern brown bandicoot in the Mount Lofty Ranges, South Australia, 2004 to 2009 (Haby & Long 2005)
- Threat abatement plan and background document for predation by the European red fox (DEWHA 2008a,b)
- Threat abatement plan and background document for predation by feral cats (DotE 2015 b,c)

- Threat abatement plan and background document for competition and land degradation by rabbits (DEWHA 2008c,d)
- Threat abatement plan for dieback caused by the root-rot fungus *Phytophthora cinnamomi* (DotE 2014).

Recommended management actions are outlined in the table below (Woinarski et al., 2014).

Conservation and Management Actions

Theme	Specific actions	Priority
Active mitigation of threats	Implement control mechanisms for non-native predators that minimise adverse impacts upon the bandicoot (e.g. predator exclusion fencing, fox baiting, feral cat control).	High
	Protect and maintain habitat in all areas where the bandicoot currently occurs.	High
	Establish corridors between fragmented populations.	High
	Avoid forestry operations within habitat, and implement forestry practices that minimise impacts on the bandicoot.	Medium
	Implement appropriate fire regimes that minimise impacts on the bandicoot, including increasing the extent of long unburnt (mature) vegetation and maintaining dense ground cover.	High
	Implement <i>Phytophthora</i> control and quarantine measures.	Medium
	Manage weeds in a manner that delivers overall benefit to the bandicoot (the control of weeds, such as blackberry, could be detrimental in some areas and a strategic approach should be considered).	Low-medium
	Implement measures to reduce road kills.	Low-medium
Captive breeding	Establish or maintain a captive breeding population for insurance and re-introductions.	Low
Translocation	Assess options and risks associated with potential to re-introduce individuals to extirpated or currently non-viable subpopulations.	Medium
Community engagement	Develop conservation covenants on lands with high value for the bandicoot.	Medium
	Liaise with the community to enhance their involvement in conservation management of the bandicoot.	Low-medium

Survey and monitoring priorities

Theme	Specific actions	Priority
Implement a comprehensive population monitoring program	Implement a long-term and rigorous monitoring program across the bandicoot's range to determine the number of individuals in subpopulations, trends in abundance, and distribution.	High
	Increase involvement of the community in surveys and their contributions to the sightings base.	Medium-high
Monitor responses to management actions	Implement a monitoring program across the bandicoot's range to assess the efficacy of management interventions, particularly responses to fox control and the consequent potential increase in cats.	Medium

Information and research priorities

Theme	Specific actions	Priority
Assess the relative impacts of threats	Define population-level impacts of foxes, cats and dogs, in rural and peri-urban settings.	High
	Define responses of populations, and of food and shelter resources, to differing fire regimes, and model longer-term impacts.	Medium-high
	Define responses to differing levels of grazing by non-native herbivores (and, where relevant, high densities of native herbivores).	Medium
	Assess the incidence of disease, including toxoplasmosis, and the factors contributing to it.	Medium
Assess effectiveness of threat mitigation options	Evaluate the mechanisms used to reduce road mortalities.	Low-medium
	Assess the relative impacts of a range of management regimes for non-native predators.	Medium-high
	Identify the critical factors that minimise the impacts of forestry and development practices.	Medium
	Identify landscape-scale options for habitat retention and connectivity.	High
Resolve taxonomic uncertainties	Define the extent of genetic differentiation (and taxonomic status) of the most disjunct subpopulations.	Medium-high
	Define the extent of genetic differentiation (and taxonomic status) for all <i>Isodon</i> taxa.	Medium
Assess habitat requirements	Identify key habitat requirements needed to minimise forestry impacts.	Medium
Assess diet and life history	Assess the extent to which food availability may limit population size or reproductive success.	Low-medium
Undertake research to	Develop broad-scale, targeted feral	Medium

develop new, or enhance existing, management mechanisms	cat control methods (that have no detrimental impacts on the southern brown bandicoot).	
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Recommendations

- (i) The Committee recommends that *Isoodon obesulus obesulus* retain its current listing status of Endangered in the list referred to in section 178 of the EPBC Act.
- (ii) The Committee recommends that there should be a recovery plan for this subspecies.

Threatened Species Scientific Committee

2/3/2016

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