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National Recovery Plan for the Mainland Eastern Barred Bandicoot *Perameles gunnii* (Victorian subspecies)



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Summary

The Eastern Barred Bandicoot *Perameles gunnii* is a small marsupial endemic to south-eastern Australia, where it occurs in Tasmania and south-western Victoria. Tasmanian and mainland populations are treated as distinct subspecies. The original wild population of the mainland subspecies is presumed extinct, and now survives in 3 reintroduced populations and 3 introduced island populations collectively comprising c. 1200 animals, and a captive population of 50 - 80 animals. Major threats include predation by the Red Fox *Vulpes vulpes*, habitat loss and prolonged drought. The impact of drought on populations may increase in severity with climate change. The mainland *Perameles gunnii* Victorian subspecies is listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Endangered in Victoria under the *Flora and Fauna Guarantee Act 1988* (FFG Act). This revised National Recovery Plan for the mainland Eastern Barred Bandicoot builds on previous plans for the subspecies (Backhouse 1992, Watson & Halley 2000, Hill *et al.* 2010) and details its distribution and biology, conservation status, threats, and recovery objectives and actions to ensure its long-term survival.

Species information

Taxonomy

Current Eastern Bared Bandicoot taxonomy follows Robinson (1995) who described genetic differentiation between mainland and Tasmanian *Perameles gunnii* and proposed that they be called different sub-species. These subspecies have not been formally described. This plan is concerned only with the Mainland Eastern Barred Bandicoot *Perameles gunnii* (Victorian subspecies).

Description

The Eastern Barred Bandicoot belongs to the marsupial family Peramelidae. It is a medium-sized terrestrial bandicoot with a body length of ~300 mm, a tail ~110 mm long, and weighs an average of 800 g. Colouration is grey-brown to buff above, somewhat paler on the sides, pale grey to white below, with 3 or 4 pale bars on the hindquarters (Brown 1989; Seebeck 1979). The Tasmanian and mainland forms are considered to be genetically different at the subspecies level (Robinson *et al.* 1993, Robinson 1995), supported by some morphological differentiation such as a slightly smaller body size in the mainland form (Seebeck 2001). However, this has not been reflected in any formal taxonomic designation, and genetic assessment is continuing (Weeks *et al.* 2013). The subspecies is short-lived and generally survives only 2-3 years in the wild, but is highly fecund. Gestation lasts 12.5 days, with average litter sizes of 2-3 being produced, although litters of up to 4 young are observed occasionally. Young bandicoots remain in the pouch for 55 days, and 3 months after birth they become independent and disperse. Females are capable of breeding from 3 months of age and can give birth to another litter immediately after the previous one has left the pouch. Reproduction can occur throughout the year, but is depressed during summer, and may cease altogether during times of drought. In favourable conditions, a single female may produce up to 5 litters a year (Seebeck 1979).

Eastern Barred Bandicoots are solitary animals and only mix with other bandicoots when breeding (Dufty 1994b). Eastern Barred Bandicoot individuals occupy partly overlapping home ranges (Jenkins 1998; Mallick *et al.* 2000), with males occupying significantly larger areas than females (females 1.9–6.4 ha, males 4–13 ha; Jenkins 1998). Historical densities have been reported as ranging from 0.45 to 5.25 animals/ha (Brown 1989; Dufty 1988, 1991; Minta *et al.* 1990), with 1.5 individuals/ha used in developing a habitat model for the taxon (Reading *et al.* 1996) and 1.0 individual/ha generally used in population viability analyses (Lees *et al.* 2013). However, densities do vary markedly within and between sites, and between years (Jenkins 1998; Minta *et al.* 1990). Mallick *et al.* (2000) reported densities in Tasmania of 0.35–2.35 animals/ha, and home ranges for males of 4.3 ha and females of 2.3 ha. More recently densities of 2.1/ha have been reported on Churchill Island (EBB Recovery Team 2017) (D. Sutherland unpublished data) and between 2.3/ha (August 2016) and 0.9/ha (September 2017) at Woodlands Historic Park (A. Coetsee unpublished data).

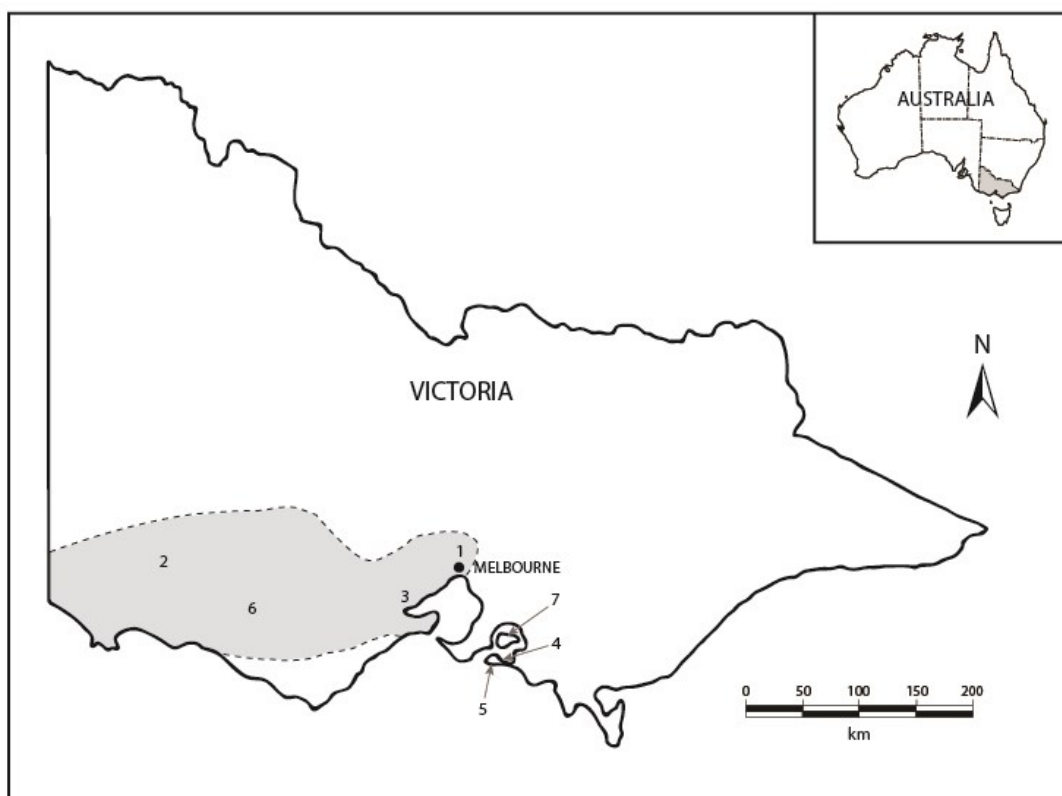
The Eastern Barred Bandicoot feeds largely on invertebrates and is primarily insectivorous; its diet includes beetles, crickets, grasshoppers, moths and earthworms (Brown 1989, Dufty 1994a, Cook 2001). Some plant material including bulbs of onion-grass *Romulea rosea* and orchard fruit is also eaten (Brown 1989; Dufty 1991). In Tasmania, hypogaeal and gasteromycete sporocarps

from hypogaeal fungi were regularly eaten (Mallick *et al.* 1997; Quinn 1985; Reimer & Hindell 1996).

Distribution

The mainland subspecies of the Eastern Barred Bandicoot formerly occurred from Melbourne through south-western Victoria to the far south-eastern corner of South Australia, occupying a total range of around 3 million ha (Figure 1: Seebeck 1979; Brown 1989; Kemper 1990). Within Victoria, the range is encompassed by the Victorian Volcanic Plains IBRA bioregion (*sensu* DEH 2000). The original wild population is now extinct. Reintroductions have been attempted at 8 locations within its former range in south-western Victoria since 1989 and more recently at 3 island sites outside its natural range. There are currently 3 extant reintroduced populations within the former range and 3 introduced island populations (Figure 1). One more reintroduction site is proposed.

Figure 1 Former distribution of *Perameles gunnii* in Victoria (grey shaded area) and location of current release sites and planned release sites



Reintroduced populations: 1 – Woodlands Historic Park; 2 – Hamilton Community Parklands; 3 – Mt Rothwell
 Introduced Island populations: 4 – Churchill Island; 5 – Phillip Island; 7 – French Island
 Planned populations: 6 – Tiverton

Habitat

Current understanding is that release sites for Eastern Barred Bandicoots should be fox-free. The habitat descriptions outlined here are to assist with site selection for establishment of any new populations.

On mainland Australia the original habitat of the Eastern Barred Bandicoot is thought to have been primarily native perennial tussock grasslands and grassy woodlands, particularly along watercourses (Brown 1989; Dufty 1994a; Seebeck 1979). There are historical records from South Australia of the subspecies occurring in open forest and scrubland (Kemper 1990). The last wild population occurred along a watercourse on the outskirts of Hamilton, a city in south-western Victoria. There, it survived in highly modified habitats such as tree plantations, farmland, gardens and parklands (Brown 1989; Dufty 1994a).

The Eastern Barred Bandicoot requires structurally complex habitats with dense cover for nesting, adjacent to more open areas suitable for feeding (Cook 2001; Dufty 1991). At reintroduction sites bandicoot diggings were associated with Black Wattle *Acacia mearnsii*, Hedge Wattle *Acacia paradoxa* and Willow Wattle *Acacia salicina*, along with Kangaroo Grass *Themeda triandra* and 4 species of herbs, and negatively correlated with bracken *Pteridium esculentum* and the lily *Arthropodium strictum* (Cook 2001). Male Eastern Barred Bandicoots ranged more widely where there was more tree cover, although only outside the breeding season (Jenkins 1998). Eastern Barred Bandicoots establish in a wider range of habitat types within fox-free sites (Winnard *et al.* 2013).

Eastern Barred Bandicoots appear to prefer areas with high soil moisture content, such as swampy depressions, poorly drained areas and along creek margins (Dufty 1991; Seebeck 1979) and in Tasmania, around dams and swampy areas (Robinson *et al.* 1991). Eastern Barred Bandicoots are reported to concentrate in areas of higher soil moisture during periods of low rainfall, possibly because of higher invertebrate numbers in those areas (Robinson *et al.* 1991), or because the moist soil is easier to forage in (Seebeck *et al.* 1990).

Decline and Threats

Since European settlement the mainland subspecies of the Eastern Barred Bandicoot has undergone a widespread and catastrophic decline in range and abundance. It is long extinct in South Australia, with the last specimen collected in the late 1800s (Kemper 1990). In Victoria, it was still widespread and even common in some districts up to 1930 (Brown 1989). After that time, there are far fewer records and they are restricted to a much smaller area in the western part of the range (Brown 1989). By 1991, the last remaining wild population of the Eastern Barred Bandicoot on mainland Australia was on the verge of extinction (Brown 1989; Clark & Goldstraw 1991; Clark *et al.* 1995; Seebeck *et al.* 1990) and a review of the recovery program concluded that the Eastern Barred Bandicoot was effectively 'lost' as a wild species and active management of the wild population ceased (Backhouse 1992).

The Tasmanian subspecies is widely distributed, however this is hypothesised to be a result of expansion into previously forested areas converted to agriculture. It is now considered rare in the Midlands, its pre-European location, due to a loss of habitat (Mallick *et al.* 1997; Driessen *et al.* 1996). Overall numbers of Tasmanian subspecies are thought to be declining (Holmes 2019).

Introduced Predators

Red Foxes are considered to be the primary cause of extinction of a number of Australian mammals, particularly small to medium-sized ground mammals such as the Eastern Barred Bandicoot (Burbidge & McKenzie 1989). The current recovery model concentrates on exclusion of foxes from translocation sites using predator-barrier fences or islands.

Cats also prey upon Eastern Barred Bandicoots, particularly juveniles (Lenghaus *et al.* 1990), however their impact on populations is thought to be less significant than that of foxes. A trial release of Eastern Barred Bandicoots onto fox-free French Island showed mortality rates from cat predation and Toxoplasmosis that appeared low enough to permit successful establishment (Groenewegen *et al.* 2017). In Tasmania, Eastern Barred Bandicoots persist in areas with feral cats.

Drought and Climate Change

During the 1997-2002 drought, populations at 4 reintroduction sites declined significantly (Winnard & Coulson 2008). These sites were also experiencing problems maintaining effective predator control, indicating that the cumulative impacts of fox predation and drought significantly elevate the likelihood of local extinction.

At feral predator-free reintroduction sites, Eastern Barred Bandicoots appear much more drought tolerant. During a period of below-average rainfall and low resource availability at Mt Rothwell, Eastern Barred Bandicoots were surviving and reproduced in the absence of foxes (Winnard *et al.* 2013).

Habitat Loss or Modification

Over 99% of Victoria's native grasslands and grassy woodlands within the Eastern Barred Bandicoot's former range have been cleared or degraded (Scarlett *et al.* 1992). The ecological community 'Natural Temperate Grassland of the Victorian Volcanic Plain', which provides

habitat for Eastern Barred Bandicoot, is a critically endangered ecological community (EPBC Act).

Habitat complexity is an important component of Eastern Barred Bandicoot habitat (Cook 2001; Dufty 1991, 1994) and a lack of habitat heterogeneity was considered to limit the area of potential habitat for the bandicoot's recovery in Hamilton (Cook 2001; Dufty 1994a). However, in the absence of feral predators, habitat complexity appears less important (Winnard *et al.* 2013).

Loss of Genetic Diversity

Weeks *et al.* (2013) reported that the entire mainland population of Eastern Barred Bandicoots were descended from 19 founders collected in 1990. Since then allelic richness, average allele numbers, observed heterozygosity and expected heterozygosity had declined substantially. He expressed considerable concern for the genetic health of the mainland Eastern Barred Bandicoot. Of particular concern was an 'undershot jaw' phenotype that was discovered across both captive and reintroduced populations. Weeks *et al.* (2013) recommended increasing population size rapidly and managing all populations as a single metapopulation to minimise further loss of genetic diversity. He also recommended investigating the introduction of new genetic diversity into the population by introducing Tasmanian Eastern Barred Bandicoot genetics through 'gene-pool mixing'.

Population Information

Wild Population

The last remaining wild population of the mainland Eastern Barred Bandicoot occurred in and around the city of Hamilton in south-western Victoria. This population is now considered extinct, with the last confirmed sighting in 2002.

Populations known to be under particular pressure of survival

Established populations of eastern Barred Bandicoots fall into 2 main groups: fenced '*in situ*' populations and introduced island populations. Fenced *in-situ* populations require ongoing management to maintain feral fencing and maintain the fenced areas free of feral predators. Island populations require management to continue to maintain them fox-free, and to control (or eradicate) feral cats.

Reintroduced Populations

Established populations of bandicoots occur at 3 sites:

Woodlands Historic Park

Woodlands Historic Park is a 220 ha reserve of open grassy woodland enclosed by a predator-barrier fence. It was the first site where Eastern Barred Bandicoots were released in 1989 (Winnard & Coulson 2008) and the population initially did well, with an estimated 600 bandicoots present in the reserve in 1994/95. However, the population then declined markedly to extinction due to fox predation, drought and overgrazing by kangaroos and rabbits (Winnard & Coulson 2008; Watson & Halley 2000). In 2011, the fence was upgraded and bandicoots were reintroduced in 2013. This new population has established across the site, with population size fluctuating between c. 50 and 500 individuals (A. Coetsee unpublished data).

Hamilton Community Parklands

The Hamilton Community Parklands is an area of 100 ha of plains and grassy woodland enclosed by a predator-barrier fence. This second Eastern Barred Bandicoot release site was established in 1990 (Winnard & Coulson 2008). The population initially did well, reaching a maximum during 1993, but declined significantly and was presumed extinct in 2005 due to fox predation and drought (Winnard and Coulson 2008). The fence was then upgraded, foxes were removed, and a second reintroduction of Eastern Barred Bandicoots grew to c. 220 animals in 2011. This population subsequently declined markedly, due to foxes entering the site. In 2016, after all foxes had been removed and the fence fixed, the small population was supplemented. The population is now (2021) established with an estimated 100-200 animals within the reserve depending on seasonal conditions. Due to the small size of this reserve, its primary purpose is now to serve as a source population for releases to larger sites.

Mount Rothwell

Mount Rothwell is a 420 ha reserve of open grassy woodlands and grasslands surrounded by an electrified predator-barrier fence. It has remained fox-free since the fence was completed in 2002. Eastern Barred Bandicoots were introduced in 2004 and are established across the

reserve. Total population size is considered to vary between c. 400 and 800 animals varying with seasonal conditions. Mount Rothwell is currently the largest population of mainland Eastern Barred Bandicoots (EBB Recovery Team unpublished data).

Introduced Island Populations

For long-term recovery of the Eastern Barred Bandicoot, the program aims to establish at least one additional large population of one thousand bandicoots or more. Reliance on predator-proof fenced areas is resource-intensive due to the costs involved in erecting and long-term maintenance of predator-proof fences. Fox-free islands that lie beyond the former range were investigated by the Recovery Team for their suitability as a more cost effective means of ensuring the long-term survival of the subspecies. These were determined to have the capacity to support large populations of Eastern Barred Bandicoots, albeit outside of their natural range. Risks of introducing a species outside of its natural range were addressed by carrying out a small research trial before larger scale introductions were proposed. Releases have subsequently occurred on 3 islands in Westernport Bay.

Churchill Island

Churchill Island is a 57 ha island free of foxes and cats. It was chosen to test the likelihood of bandicoots establishing successfully and evaluate any negative impacts to island values, ahead of a release onto the much larger, neighbouring islands of Phillip Island and French Island. Twenty bandicoots were released onto this introduced-predator free island in 2015, and they are now established across the island with a population size of 60-120 individuals. No negative impacts on existing biodiversity or farming practises have been detected (D. Sutherland unpublished data). This trial paved the way for an Eastern Barred Bandicoot release on Phillip Island.

Phillip Island

Phillip Island is a 10,000 ha island and is estimated to have c. 9,000 ha of potential Eastern Barred Bandicoot habitat across public and private land. A fox control program has completely eradicated foxes from the island. Feral cat densities were reduced to 1.1-1.6/km² at a planned release site, and 67 Eastern Barred Bandicoots were released there in spring 2017. The population is established at the reintroduction site and is expanding across the island. The estimated population potential of Phillip Island is 9000-18000 individuals.

French Island

French Island is an 18,000 ha fox-free island with an established feral cat population across the island. There is an estimated 9,000 ha of suitable Eastern Barred Bandicoot habitat across public and private land, primarily in previously cleared areas. Eastern Barred Bandicoots were introduced in spring 2019 and their establishment is being monitored. The estimated population potential of French Island is 9000-18000 individuals.

Tiverton

Tiverton is a 1,000 ha private grassland reserve within the former range of the Eastern Barred Bandicoot. A predator-barrier fence surrounding the property was completed in summer 2017/18. Eradication of foxes, feral cats and rabbits from the reserve was completed in early 2020, and Eastern Barred Bandicoots reintroduced there in late 2020.

Table 1 provides estimates of population and sub-population sizes of Eastern Barred Bandicoot. Estimates are based on the most recent data collected in the field (R. Hill pers. comm.).

Table 1 Estimates of population and sub-population sizes of Eastern Barred Bandicoot

Site name	Available habitat	Population source/type	Predator protection mechanism	Land manager	Population status 2021	Population potential*
Woodlands Historic Park	220 ha	Reintroduced within range	Barrier fence	Parks Victoria	Establishing	200–400
Hamilton Community Parkland	100 ha	Reintroduced within range	Barrier fence	Southern Grampians Shire Council	Established	100–200
Mount Rothwell	420 ha	Reintroduced within range	Barrier fence	Private conservation reserve – East View Valley Pty Ltd	Established	400–800
Churchill Island	57 ha	Island assisted colonisation	Fox and cat-free island	Phillip Island Nature Parks	Established	60–120
Phillip Island	9000 ha	Island assisted colonisation	Fox-free island Targeted feral cat control	Phillip Island Nature Parks	Establishing	9,000–18,000
Tiverton	920 ha	Reintroduced within range	Barrier fence	Private conservation reserve – Tiverton Property Partners	Establishing	900–1,800
French Island	9000 ha	Island assisted colonisation	Fox-free island Targeted feral cat control	Parks Victoria	Establishing	9,000–18,000
Total	19,717 ha	–	–	–	–	19,660–39,320

* Based on density of 1-2 animals/ha.

Important populations

While all Eastern Barred Bandicoot populations are important, given the overall small number of populations and need to maintain minimum population size for genetic diversity retention, the highest priority populations are those sites that are largest in habitat area and therefore have the highest ultimate population potential:

- Mount Rothwell
- Phillip Island.

Introduction sites that are likely to become high priority populations if releases are successful are:

- French Island
- Tiverton.

Past Management Actions

Action	Description
Eastern Barred Bandicoot Recovery Team	In 1989, the Mainland Eastern Barred Bandicoot was on the brink of extinction. This led to the formation of a multi-organisational Recovery Team that coordinated a recovery program focusing on predator control, habitat management and captive breeding. The Recovery Team includes representatives from Conservation Volunteers Australia, DELWP, Mt Rothwell Biodiversity Interpretation Centre, National Trust of Australia, Parks Victoria, Phillip Island Nature Parks, University of Melbourne, Tiverton Property Partnering and Zoos Victoria.
Captive Management	<p>Following the effective extinction of the wild population, a captive breeding program commenced in 1990 with 19 effective founders, to insure against catastrophic loss of reintroduced and introduced populations. All mainland Eastern Barred Bandicoot populations are originally derived from this program. The program is administered by Zoos Victoria and animals are bred across 5 locations (Werribee Open Range Zoo, Melbourne Zoo, Serendip Sanctuary, Healesville Sanctuary and Kyabram Fauna Park), with a further 3 locations housing post-reproductive animals. The captive population also includes animals for display, to raise awareness of the Eastern Barred Bandicoot and its conservation (Parrott <i>et al.</i> 2017).</p> <p>Since 2011, the program has maintained 15 breeding pairs in zoological institutions, which are turned over every 2 years with new animals sourced from the reintroduced and (more recently) introduced populations. This strategy aims to maximise retention of genetic diversity within the captive program. More than 920 animals have been bred, and 577 have been released from captivity into fenced and wild locations. The captive program also provides opportunities for research, and to promote awareness of the recovery of the species (Parrott <i>et al.</i> 2017).</p>
Establishment and Management of Reintroduced Fenced Populations	<p>A long-term program of reintroductions has been operating since 1991. Eight reintroductions were attempted in this period of which 3 succeeded. These 3 reintroduced populations are established at predator-proof fenced sites at Hamilton Community Parkland, Woodlands Historic Park and Mount Rothwell. A comprehensive review of these reintroductions is provided by Winnard and Coulson (2008). A fourth site at 'Tiverton' is still establishing.</p> <p>All reintroduction sites have a comprehensive predator monitoring and control program. Regular fence monitoring and maintenance help to ensure that these sites remain fox free. Within fenced sites, macropods and rabbit populations are controlled or removed to prevent grazing impacting bandicoot habitat quality and to avoid macropod welfare issues.</p>
Introduction and Management of Eastern Barred Bandicoots to island locations	<p>Following small-scale releases of Eastern Barred Bandicoots at French Island in 2012 and Churchill Island in 2015, positive results led to a large-scale introduction program. Animals were released on Phillip Island in Spring 2017 and French Island in Spring 2019.</p> <p>On fox-free islands, control of feral cats is undertaken, particularly during population establishment.</p>
Genetic diversity	<p>The population size has been increased rapidly to prevent further loss of genetic diversity, from greater than 70 animals at the time of genetic assessment, to a population size of 750-1115 in 2018. At this range in population size, further loss of genetic diversity is minimised (A. Weeks pers. comm.). Furthermore, the national recovery program has instated a plan for managing all populations as a single metapopulation, with documented transfer of individuals between sites to maximise the effective population size.</p> <p>A gene-pool mixing trial with Tasmanian males was commenced in 2016, and 26 male animals have been relocated from Tasmania to Mount Rothwell. This trial has shown that outcrossed individuals have markedly higher genetic diversity than the mainland population, with no negative consequences for fitness. A crowdfunding campaign in 2018 successfully secured funding to facilitate additional males being introduced into the breeding program from Tasmania. Introduction of this new genetic diversity to all populations of Mainland Eastern Barred Bandicoots is a priority for this plan.</p>
Habitat management and predator and herbivore	All reintroduction sites have a comprehensive predator monitoring and control

Action	Description
control	<p>program.</p> <p>Mount Rothwell, Hamilton and Woodlands Historic Park fenced reintroduction sites are maintained free of foxes and a fox control program has completely eradicated foxes from Phillip Island since 2017 and Churchill Island since 2007.</p> <p>Fenced reintroduction sites are monitored and managed for feral cats. Cats were eradicated on Churchill Island in 1998. Feral cats were intensively managed at the Phillip Island release site prior to introduction of Eastern Barred Bandicoot. Feral cat control has been undertaken since 2001 at French Island, and efforts have recently been strengthened through the inclusion of French Island in the Commonwealth's 'Five Feral Cat-Free Islands' program in 2016, with the objective of complete eradication of feral cats by 2020, and by the declaration in Victoria in 2018 of feral cats as an established pest on crown land.</p> <p>Native and feral herbivores are managed at Mount Rothwell and Hamilton to limit total grazing pressure and minimise any impacts on Eastern Barred Bandicoot habitat quality. Rabbits were eradicated from Churchill Island in 1999. At Woodlands, Parks Victoria has been undertaking stakeholder engagement and community education to garner support for macropod management.</p> <p>Ongoing control of environmental weeds is undertaken at all 3 fenced reintroduction sites and Churchill and Phillip Islands.</p>
Research	<p>A range of research projects have been carried out or are underway to improve knowledge of the subspecies and support recovery activities:</p> <ul style="list-style-type: none"> • Guardian Dogs: Three unfenced mainland sites within the historic range of the subspecies have been prepared for release of Eastern Barred Bandicoot accompanied by guardian dogs: Mooramong (NW Skipton), Tiverton (NE Mortlake) and Dunkeld (south of Dunkeld). Italian guardian sheepdogs (maremmas) have been progressively trained since 2015 in fox protection and bonding with bandicoots in readiness for the releases (Parrott <i>et al.</i> 2017). • Bandicoot digging: this project investigated how Eastern Barred Bandicoot digging impacts soil health and invertebrate populations, with the aim of building support for introduction of the subspecies (Halstead 2017). • Toxoplasmosis: this project investigated the impact of Toxoplasma infection on Eastern Barred Bandicoot population establishment and persistence (Adriaanse 2018). • Predator aversion: As the natural prey of bandicoots are birds of prey which detect prey through movement, the defence mechanism of bandicoots is to freeze. This places bandicoots at risk from cats which use scent, sound and movement to detect prey. Bandicoots that were released in the Phillip Island introduction were trained in predator aversion. An evaluation will be undertaken to determine whether this contributed to establishment success. • Transmitter trials were undertaken to determine methods with least harm to Eastern Barred Bandicoot health and longest period of reliable attachment (Coetsee <i>et al.</i> 2016). • Mate choice: Research was undertaken on mate choice in the captive breeding program and its influence on breeding success (Hartnett <i>et al.</i> 2018). • The diet of Eastern Barred Bandicoot was examined at island introduction sites to contribute knowledge of any impacts of introduction of the subspecies outside of its indigenous range (Loeffler 2018). • Research to optimise analytical methods to qualify the density and demographics of Eastern Barred Bandicoots from live trapping and camera trapping monitoring techniques is underway (Groenewegen in prep.). • Research has been carried out to identify habitat use and movement ecology of Eastern Barred Bandicoots during early establishment (Rendall <i>et al.</i> 2018). • Community dynamics models are being developed to help predict the outcome of predator and herbivore management on bandicoot establishment success (Rendall in prep.).
Engagement	<p>A communications strategy has been produced to align messaging by recovery team member organisations.</p> <p>The recovery team has had a very successful engagement program, with the production</p>

Action	Description
Monitoring, development of monitoring protocols, and curation of data	<p>of a newsletter, the recent success of the crowdfunding campaign to enhance the genetic viability, education through visitation opportunities at Mount Rothwell, Phillip Island Nature Parks and Zoos Victoria, and media interest in programs such as the guardian dog trial.</p> <p>The Eastern Barred Bandicoot program has achieved a high profile at state level and nationally.</p> <p>Annual estimates of population size have been produced for all sites using a combination of distance sampling and cage trap methods. There has been an increase in confidence of population estimates as methods of monitoring have been improved.</p>

Recovery Information

Current State of Knowledge

This new plan proposes to implement the most cost-effective, successful actions from the past plan, refined and improved by new findings. The results arising from the last plan have confirmed that we can achieve the long-term objective for the Eastern Barred Bandicoot through a combination of fenced populations in situ, as well as the confidence to continue with the management of island populations. The successful gene pool mixing trials now mean we will now, with confidence, establish these outbred animals across all Eastern Barred Bandicoot sites.

The focus of the recovery program for the Eastern Barred Bandicoot is to establish large fox-free reserves and islands, in order to establish large self-sustaining populations that can persist during unfavourable environmental conditions, such as drought.

The recovery model for this subspecies uses the following logic:

- Release sites that exclude foxes are the most likely to successfully establish self-sustaining populations.
- Eastern Barred Bandicoots are able to establish populations in (at least) low densities of feral cats.
- Habitat choice by Eastern Barred Bandicoots within fox-free sites is much broader than previously reported.
- Fox-free populations of Eastern Barred Bandicoots appear to be much more drought resilient than previously considered.

There has been considerable loss of genetic diversity (c. 30-40%) within the mainland population of the Eastern Barred Bandicoot over the past 30 years (Weeks *et al.* 2013). In 2010, Hill *et al.* identified an urgent need to rapidly increase total population size to minimise any further loss of genetic diversity. This has since been the highest priority of the recovery program. Since 2010, total population size including the captive program has markedly increased to a minimum of c. 1200 animals, at which further loss of genetic diversity is now minimised (A. Weeks pers. comm.). A long-term target of 2500 animals was set in a review of the program in 2007 based on habitat suitability modelling (Reading *et al.* 1996). To reach this objective, additional fox-free suitable habitat is required.

Further opportunities to establish new populations within the former range are limited by the lack of suitable sites, and would require major new investment in further land acquisition, predator-barrier fencing and ongoing management. For this reason, the Recovery Team is not proposing to establish additional sites within this natural range. Instead we are establishing Eastern Barred Bandicoots onto large fox-free islands, such as Phillip Island and French Island. In addition to the existing reintroduction sites, island introductions appear to offer the best chance of securing the long-term conservation of this subspecies using the least resources.

Current and Recent Research

The Eastern Barred Bandicoot recovery team is targeting critical knowledge gaps in the recovery model. The following projects are currently underway:

- Gene-pool mixing: this project is trialling outbreeding with Tasmanian Eastern Barred Bandicoots to enhance genetic diversity and mitigate the negative impacts of inbreeding, to maximise long-term adaptive potential of populations of Mainland Eastern Barred Bandicoots.
- Guardian dogs: this trial is exploring the feasibility of using guardian dogs to protect Eastern Barred Bandicoot populations at unfenced sites within the former distribution.
- Toxoplasmosis: this project is seeking to understand the impact of Toxoplasma infection on population establishment and persistence.
- Prey detection training: this project is training Eastern Barred Bandicoots in predator evasion techniques and evaluating influence on introduction success.
- Mate choice trials to improve reproductive success and quality in captive breeding (Harnett *et al.* 2018).
- Bandicoot digging: this project (completed in 2017) investigated how Eastern Barred Bandicoot digging impacts soil health and invertebrate populations with the aim of building support for introduction of the subspecies.

Management

More than 2 decades of monitoring data at fenced sites has revealed that at reintroduced and introduced populations, Eastern Barred Bandicoot densities vary typically between 1-2 animals per hectare, and that densities are ultimately limited by social avoidance (EBB recovery team unpublished data). Several decades of fenced populations demonstrate that Eastern Barred Bandicoots do not reach densities where they over-utilise their resources, or animal welfare issues arise. This is also the case at Churchill Island where Eastern Barred Bandicoots now occupy the entire island, with densities plateauing 2 years after establishment at similar densities to reintroduction sites. Studies of the Churchill Island introduction reported no negative impacts on other island biodiversity, or on the resident small farm (EBB recovery team). In addition, Eastern Barred Bandicoot digging increased soil moisture and reduced soil compaction on the island (Halstead 2017).

Management of Reintroduced Fenced Populations

Retaining predator exclusion from reintroduction sites is critical. Regular, preferably daily, fence monitoring and maintenance are essential in ensuring that these sites remain fox-free. All reintroduction sites have a comprehensive predator monitoring and control program.

Within fenced sites, macropod and rabbit populations require control or preferably removal, to prevent grazing impacting bandicoot habitat quality and to avoid macropod welfare issues.

Management of Introduced Island Populations

On fox-free islands, feral cats are the greatest risk to successful establishment of Eastern Barred Bandicoots. Control of feral cats at island release sites is considered important, particularly during population establishment. Maintaining low cat densities is almost certainly favourable, although Tasmanian Eastern Barred Bandicoots are known to coexist in the presence of feral cats.

Relevant national threat abatement plans

- [Threat abatement plan for predation by European red fox](#) – 2008
- [Threat abatement plan for predation by feral cats](#) – 2015

Captive Management

Captive Population

A captive breeding program has as its main goal providing insurance against catastrophic loss of reintroduced and introduced populations. The program commenced in 1990 with the effective extinction of the wild population and has 19 effective founders. All mainland Eastern Barred Bandicoot populations are originally derived from this program. Zoos Victoria administers the program and animals are bred across 5 locations (Werribee Open Range Zoo, Melbourne Zoo, Serendip Sanctuary, Healesville Sanctuary and Kyabram Fauna Park), with a further 3 locations housing post-reproductive animals. The captive population also includes animals for research and display, to raise awareness of the Eastern Barred Bandicoot and its conservation (Parrott *et al.* 2017).

Since 2011 the program has maintained 15 breeding pairs in zoological institutions, which are turned over every 2 years with new animals sourced from the reintroduced and (more recently) introduced populations. This strategy aims to maximise retention of genetic diversity within the captive program. Suitable young animals contribute to founder groups for new populations, along with animals from existing populations. The captive program also provides opportunities for research, and to promote awareness of the recovery program (Parrott *et al.* 2017).

The captive program will cease when all proposed reintroductions or introductions have established, sufficiently to no longer require an insurance population.

Benefits to other Species/Ecological Communities

The Eastern Barred Bandicoot is one of many species of threatened fauna and flora, and ecological communities occurring in the Volcanic Plains of south-western Victoria. The grasslands and grassy woodlands habitats of the Eastern Barred Bandicoot on the Victorian Volcanic Plains are themselves threatened.

Under the EPBC Act, ecological communities that are associated with the Eastern Barred Bandicoot include:

- ‘Natural Temperate Grassland of the Victorian Volcanic Plain’; listed as Critically Endangered.
- ‘Grassy Eucalypt Woodland of the Victorian Volcanic Plain’; listed as Critically Endangered.
- Elements of the ‘White Box-Yellow Box-Blakely’s Red Gum Grassy Woodland and Derived Native Grassland’; listed as Critically Endangered.
- Other ecological communities that may provide habitat but are more localised in distribution, including the Critically Endangered: ‘Natural Damp Grassland of the Victorian Coastal Plains’, and ‘Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains’.

The 'Western (Basalt) Plains Grasslands Gum) Grassy Woodland Floristic Eastern Barred Bandicoot is a plains. Conservation actions for the species found in grassland and grassy woodland habitats

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Appendix A: Nationally threatened flora and fauna).

Larger fox-free reintroduction sites for Eastern Barred Bandicoots may also support reintroduced populations of other threatened fauna such as the Eastern Quoll.

On islands, any long-term control of feral cats has the potential to benefit other nationally listed species such as the Eastern Curlew, Hooded Plover, Fairy Tern and Long-nosed Potoroo.

Social and Economic Impacts

The 2 largest Eastern Barred Bandicoot reintroduction sites are privately owned and operated, with some public investment. Once established, these 2 sites will provide 2 of the 4 sites required for long-term recovery (see 'Long-term Objective'). This is a very tangible demonstration of the direct impacts of private conservation. The protection of remnant habitat (especially endangered native grasslands and grassy woodland communities) provides direct benefits to native species and communities and to primary production. There is considerable public interest in and volunteer involvement with reintroduced populations of bandicoots, and the species has a high profile in Victoria.

Bandicoots may be beneficial across farmland as they eat pasture pests such as cockchafer grubs and onion grass bulbs.

Affected Interests

Table 2 contains a list of organisations with an interest in the implementation of this plan.

Table 2 Organisations with an interest in the implementation of the National Recovery Plan for the Mainland Eastern Barred Bandicoot *Perameles gunnii* (Victorian subspecies)

Organisation	Role/Involvement
Traditional Owners	Participation in recovery action implementation
Conservation Volunteers Australia	Woodlands Historic Park
Department of Environment, Land, Water and Planning, Victoria	Convenor of Recovery Team
East View Valley Pty Ltd	Mount Rothwell reintroduction site
National Trust	Owners of 'Mooramong': location of guardian dog trial, former reintroduction site, captive program
Parks Victoria	Land manager of Woodlands Historic Park and French Island National Park
Phillip Island Nature Parks	Land manager of Churchill Island and Crown Land on Phillip Island including Summerland Peninsula, lead recovery actions on these islands
The University of Melbourne (School of BioSciences and CESAR)	Genetic conservation, ecological advice, research partner
Tiverton Property Partners	Owners of 'Tiverton' reintroduction site and partner in the Guardian Dog trial
Zoos Victoria	Captive program, Guardian Dogs, lead recovery actions on French Island

Role and Interests of Indigenous People

The former and current distribution of the mainland Eastern Barred Bandicoot (including introduced populations) spans the traditional country of the Traditional Owner groups shown in Table 3.

Table 3 Role and Interests of Traditional Owner Groups

Group	Country
Bunurong Land Council Aboriginal Corporation	Country intersects Churchill, Phillip and French Islands
Wurundjeri Tribe Land and Compensation Cultural Heritage Council	Country intersects eastern part of range including Woodlands Historic Park
Wathaurung Aboriginal Corporation	Country intersects eastern part of range including Mt Rothwell
Eastern Maar Aboriginal Corporation	Country intersects mid part of range including 'Tiverton'
Gunditj Mirring Traditional Owners Aboriginal Corporation	Country intersects western part of range including Hamilton Community Parklands
Bunganditj or Boandik people	Country includes the coastal area from the south of Robe, South Australia, to the area around the mouth of the Glenelg River at Nelson, Victoria

Bandicoots were a traditional food source in Victoria (Hamilton 1981[1914]; Thomas c. 1854). Indigenous names for Eastern Barred Bandicoot include *warron* in Koornkopianoot, Peek woorroong (Dawson 1881) and Keerray-Woorroong dialects (Martin and Handasyde 1999) in

south-west Victoria, *waitung* (Blake 2011)/*wydung* (Thornly 1878) in Jardwadjali dialect in country north-west of Hamilton, and *watjun* (Blake 2011)/*wateun* (Dawson 1881) in Djab Wurrung dialect in country north-east of Hamilton (dialect names as per Victorian Aboriginal Corporation for Languages 2016).

Traditional Owners have been engaged in the development of this recovery plan. Traditional Owners have previously participated in Eastern Barred Bandicoot recovery activities, and have expressed interest in ongoing involvement in recovery actions as a means for building technical knowledge, capacity, and connection to Country, particularly in enabling engagement of Indigenous natural resource management teams. The trans-Country boundary distribution of the subspecies, and recovery actions involving genetic mixing across traditional Country areas, are noted by Traditional Owner groups as a potential means of engendering cultural connections between groups and sharing learnings and experiences. Traditional Owner groups also view Eastern Barred Bandicoot recovery activities as an opportunity to develop cultural use and management of natural resources more broadly, beyond single species recovery.

All responsible organisations and partners will ensure that implementation of relevant actions is undertaken with the approval and cooperation of the organisations listed above. All activities will respect the cultural knowledge and traditions of Indigenous people throughout the subspecies range.

Recovery Objectives and Actions

Long-term Objective

The overall objective of this recovery plan is to secure the long-term evolutionary potential of the mainland Eastern Barred Bandicoot by establishing and maintaining a minimum of 4 genetically diverse, spatially independent, self-sustaining reintroduced populations which total no less than 2500 individuals.

Short-term 10-year Objective

Within the lifespan of this Recovery Plan, the recovery objectives for the mainland subspecies of the Eastern Barred Bandicoot are to:

- Maintain or improve genetic integrity
- Increase number of populations
- Increase population size.

To meet these objectives, there are a number of specific objectives which have been developed for the period of this Recovery Plan:

- Specific Objective 1: Support the existing three reintroduction and three introduction sites
- Specific Objective 2: Establish one new reintroduction site within the original range
- Specific Objective 3: Establish at least two self-sustaining island populations
- Specific Objective 4: Increase population size to maintain genetic variation
- Specific Objective 5: Introduce outbred individuals to all established and new sites
- Specific Objective 6: Phase out the captive breeding program when no longer required
- Specific Objective 7: Research into establishing and maintaining bandicoot populations
- Specific Objective 8: Maintain and/or enhance community and agency engagement and support.

Program Implementation and Evaluation

The Recovery Plan will run for 10 years from the time of adoption and its implementation will be managed by the Department of Environment, Land, Water and Planning (DELWP). The Eastern Barred Bandicoot Recovery Team will continue to oversee recovery actions for the subspecies in Victoria. Progress will be monitored and evaluated annually by the Recovery Team through a structured review process. This will include compiling information and data and assessing progress made for all actions against the criteria and objectives of the Recovery Plan and specific quantitative recovery targets. There will be an external review of the recovery program after 4 years of Recovery Plan implementation. This Recovery Plan will be reviewed and revised within 10 years of the date of its adoption.

Recovery Objectives, Actions and Performance Criteria

Objective: Increase population size

Specific Objective 1: Support the existing three reintroduction sites (Mt Rothwell, Woodlands and Hamilton) and three island population sites (Churchill, French and Phillip Islands)

Key Performance Criterion:

Each site is managed to maximise its population potential

Table 4 Specific Objective 1: Support the existing three reintroduction sites (Mt Rothwell, Woodlands and Hamilton) and three island population sites (Churchill, French and Phillip Islands)

Action No.	Action Description	Action Details	Performance criteria
1.1	Prevent incursions of exotic predators to established sites. Responsibility: Conservation Volunteers, Mount Rothwell, DELWP, Parks Victoria, Tiverton.	Ensuring existing fenced reintroduction sites are fox and cat free is critical to success, with foxes identified as a key factor in previous reintroduction failures. Fences to be patrolled on a minimum weekly basis to monitor for signs of predator access and fence failure, and fences repaired immediately. Sites to be regularly monitored for signs of predators and any feral predators that are detected to be removed. Continual monitoring of Churchill and Phillip Islands to be undertaken to ensure their fox-free status is maintained. While Churchill Island is cat free, efforts will continue to control feral cats on Phillip Island below the density where they impact on bandicoot population persistence. Predator activity and control program impacts, and frequency and extent of fence maintenance to be reported annually to assist in evaluating the cost of the recovery program and improve knowledge of predator impacts on bandicoot population trajectories.	Sites monitored at least weekly for signs of predator incursions. Predators removed within 2 weeks of detection at fenced sites. Feral-proof fences monitored weekly for signs of damage, and repairs made in a timely manner. Population sizes not depleted by foxes. Feral cat density on Phillip Island reduced to 1.1 cats/km ² .
1.2	Optimise habitat conditions for Eastern Barred Bandicoots through herbivore control and weed	Overgrazing by native and feral herbivores has potential to limit habitat availability to Eastern	Habitat condition/vegetation cover not limiting

Action No.	Action Description	Action Details	Performance criteria
	management. Responsibility: Mount Rothwell, PV, DELWP, Tiverton, CVA	<p>Barred Bandicoot. For example, at Mt Rothwell in 2013 the bandicoot population was limited by severe rabbit grazing and only increased once rabbit numbers were controlled.</p> <p>Vegetation cover and herbivore activity to be monitored on a regular basis in conjunction with bandicoot population monitoring to ensure early intervention as required.</p> <p>When overgrazing levels are triggered, macropod and rabbit control or preferably removal to be undertaken, to prevent grazing impacting bandicoot habitat quality and to avoid macropod welfare issues.</p> <p>Macropod control is a key challenge at Woodlands where public response has prevented management being undertaken. The land manager to continue community education and engagement to garner support for native herbivore manager programs.</p> <p>Weed management focused on key high threat grassland weed species to be undertaken in a staged program to ensure replacement with suitable indigenous species. This will allow gradual replacement of bandicoot harbour without significant impact to bandicoot population which may be utilising weed species for habitat.</p>	population expansion at 4 sites.
1.3	Monitor Eastern Barred Bandicoot population Responsibility: Recovery Team	<p>Monitoring of each population will be undertaken at least annually to assess the trajectory of the subspecies and provide a total population size.</p> <p>Monitoring data will help to determine successful achievement of recovery objectives and to trigger management interventions as required.</p> <p>A combination of distance sampling, camera trapping and cage trap methods will be used in monitoring.</p>	Annual estimates of total population size produced for each site and recorded in a central database.

Action No.	Action Description	Action Details	Performance criteria
1.4	Develop triggers for management intervention at all sites Responsibility: Recovery Team	Population records will be maintained by the Eastern Barred Bandicoot recovery team in a central database. Develop triggers for intervention based on habitat, population and genetic trajectories.	Intervention triggers established which link directly to population and habitat monitoring measures.

Objective: Increase number of populations

Specific Objective 2: Establish one new reintroduction site within the original range (Tiverton)

Key Performance Criterion:

Population of Eastern Barred Bandicoots established at Tiverton

Table 5 Specific Objective 2: Establish one new reintroduction site within the original range

Action No.	Action Description	Action Details	Performance criteria
2.1	Develop a fence monitoring and maintenance strategy Responsibility: Tiverton Property Partners, ZV, DELWP.	A fence monitoring and maintenance strategy to be developed to ensure the integrity of the site is maintained.	Fence strategy in place. Funding secured for maintenance and monitoring of the predator barrier fence.
2.2	Remove all feral predators Responsibility: Tiverton Property Partners	All foxes and cats within the fenced area to be detected and eliminated prior to the reintroduction.	No foxes or cats detected within the fenced area at time of reintroduction. Funding secured for ongoing predator monitoring and control.
2.3	Control introduced and native herbivore grazing Responsibility: Tiverton Property Partners	To protect habitat and foraging areas, overgrazing rabbits and native herbivores to be controlled from within the fenced area. Sheep grazing to be managed in line with Bandicoot habitat requirements.	Rabbits or native herbivores maintained within the fenced area prior to reintroduction. Funding secured for ongoing herbivore monitoring and control.
2.4	Control environmental weeds Responsibility: Tiverton Property Partners	A weed control program targeted at environmental weeds to be designed and implemented.	A targeted and funded weed program is in place.
2.5	Prepare and implement the reintroduction of an Eastern Barred Bandicoot population into	A translocation plan to be developed, including success criteria, for approval by the Threatened	Release of Eastern Barred Bandicoot to new mainland introduction site.

Action No.	Action Description	Action Details	Performance criteria
	Tiverton Responsibility: Tiverton Property Partners/DELWP	Fauna Translocation Evaluation Panel, and all legal requirements will be obtained. Following the reintroduction event, animals will be monitored to understand post-release movements and habitat use, and to identify factors that influence post-release survival and establishment success to refine future release strategies and identify ongoing threats.	Population densities of at least one Eastern Barred Bandicoot per hectare across the new site reached by year 5 of this plan. Success criteria for reintroduction, as detailed in the translocation plan, evaluated and achieved.
2.6	Following the reintroduction of the Eastern Barred Bandicoot, implement actions in line with existing reintroduction sites Responsibility: Tiverton Property Partners	See actions under Objective 1.	—

Objective: Increase population size

Specific Objective 3: Establish at least two self-sustaining island populations

Key Performance criterion: Populations of Eastern Barred Bandicoots established at a minimum of 2 island populations (Phillip Island and French Island)

Table 6 Specific Objective 3: Establish at least two self-sustaining populations

Action No.	Action Description	Action Details	Performance criteria
3.1	Control and monitor exotic predators Responsibility: ZV, PV	French Island is fox-free, a key requirement for successful introduction of Eastern Barred Bandicoot. Continual fox monitoring of French Island to be undertaken to detect incursions prior to and post introduction of Eastern Barred Bandicoot. In the absence of foxes, cats pose the highest threat to an introduction, particularly during population establishment. Four of the recorded mortalities that occurred in the 2012 French Island reintroduction trial release of 18 animals were found to be due to cat predation and toxoplasmosis (Groenewegen <i>et al</i> 2017). Cat removal is being targeted on French Island as part of the Commonwealth 'Five Feral Cat-Free Islands' program, with complete eradication by	Feral predator density not impacting likelihood of establishment and persistence of introduced population.

Action No.	Action Description	Action Details	Performance criteria
3.2	Gain landholder and licencing permission Responsibility: ZV	<p>2025 Cat activity and the presence of toxoplasmosis to be monitored, and cat control continue to be undertaken, prior to and post introduction of Eastern Barred Bandicoot.</p> <p>Absence of foxes is monitored by reports by public and observations by PV staff.</p> <p>After an extensive period of community engagement, the community of French Island supported the introduction of Eastern Barred Bandicoot. All necessary landholder permissions were obtained.</p> <p>A translocation plan was developed for approval by the Threatened Fauna Translocation Evaluation Panel, and all legal approvals obtained.</p> <p>EPBC exemption to remove EPBC protections from EBB populations on private land.</p>	Translocation plan approved and all permissions secured.
3.3	Prepare and implement the reintroduction of an Eastern Barred Bandicoot population into French Island Responsibility: ZV	<p>Animals were sourced from the captive breeding population and other sites, and released in accord with translocation plan protocols.</p>	<p>Release of Eastern Barred Bandicoot to French Island.</p> <p>Population densities of at least one Eastern Barred Bandicoot per hectare across the new site reached by year 5 of this plan.</p> <p>Success criteria for reintroduction, as detailed in the translocation plan, evaluated and achieved.</p>
3.4	Once an Eastern Barred Bandicoot population is established on French Island, implement actions in line with established sites Responsibility: ZV	Carry out ongoing management activities in accordance with Objective 1.	–

Objective: Maintain or improve genetic integrity

Specific Objective 4: Increase population size to maintain genetic variation

Key Performance Criterion:

All Eastern Barred Bandicoot populations managed to maximise their population size

All Eastern Bandicoot populations managed as one meta-population

Table 7 Specific Objective 4: Increase population size to maintain genetic variation

Action No.	Action Description	Action Details	Performance criteria
4.1	Maximise population size at all sites Responsibility: Recovery Team	Genetic assessment indicated the need to rapidly increase population size within the next few generations (Weeks <i>et al.</i> 2013) to retain genetic diversity levels. The total population size across sites will be increased to >2500 individuals, primarily through introduction at French Island (see Objective 3) and Tiverton (see objective 2).	Genetic diversity of the Eastern Barred Bandicoot at least maintained at 2010 levels, and a total population size of 2500 reached within 5 years of the commencement of the recovery plan.
4.2	Monitor genetic diversity in populations Responsibility: Recovery Team	Genetic diversity to be monitored at least every 2 years or more often where necessary using standard approaches. Triggers to be determined for intervention actions, and management actions implemented when triggers are met.	Genetic diversity estimates carried out at least every 2 years. Action taken to increase genetic variation as triggers are reached.
4.3	Institute meta-population management Responsibility: Recovery Team	To stop the decline in genetic variation, Weeks <i>et al</i> (2013) recommended that populations not be isolated from each other. A Meta-population plan to be developed to guide transfer of animals and implemented to ensure all populations are treated as a single meta-population and that documented transfer of animals occurs between sites.	Meta-population plan developed and implemented. Genetic diversity of the Eastern Barred Bandicoot at no less than 2010 levels.

Objective: Maintain or improve genetic integrity

Specific Objective 5: Introduce outbred individuals to all established and new sites

Key Performance Criterion:

Outbred animals successfully breeding at all established and new sites

Table 8 Specific Objective 5: Introduce outbred individuals to all established and new sites

Action No.	Action Description	Action Details	Performance criteria
5.1	Develop a strategy for cross-breeding with Tasmanian individuals, and establish a site with outbred individuals Responsibility: Recovery Team	Weeks <i>et al</i> (2013) recommended that as well as an increase in population size to stop genetic decline, cross-breeding with Tasmanian Eastern Barred Bandicoot would be required to increase genetic diversity, and managed carefully so that adaptations unique to Mainland Eastern Barred Bandicoot are maintained. In 2017-2018, male Tasmanian bandicoots were mated with Mainland females at Mount Rothwell and outcrossed animals were found to have markedly higher genetic diversity with no negative fitness issues. A successful crowdfunding exercise in late 2018 brought an additional 15 Tasmanian male Eastern Barred Bandicoots to Victoria with the aim of increasing genetic diversity by up to 80%. The population of outbred individuals at Mount Rothwell to be increased and monitored to ensure adequate presence of Tasmanian founder genes, to be used as a source population for gene mixing across the Mainland meta population. A strategy will be developed for transferring outbred individuals to all sites.	A population of outbred Mainland Eastern Barred Bandicoots with the required number of Tasmanian founder genes established. A strategy in place for implementing gene pool mixing across all sites.
5.2	Introduce outbred individuals to all established and new sites Responsibility: Recovery Team	Outbred individuals to be introduced to all established and new sites as identified in the gene pool mixing strategy.	Releases of outbred individuals at all established sites undertaken
5.3	Monitor genetic diversity across sites to ensure uptake of Tasmanian genes Responsibility: Recovery Team	Use genetic markers to monitor the overall flow level of Tasmanian genes into the Mainland meta-population and ensure adequate uptake.	Gene flow of Tasmanian genes meets target identified in the gene pool mixing strategy

Objective: Increase population size

Specific Objective 6: Phase out the captive breeding program when no longer required

Key Performance Criterion:

Review of captive breeding rationale completed within lifetime of this plan

Table 9 Specific Objective 6: Phase out the captive breeding program when no longer required

Action No.	Action Description	Action Details	Performance criteria
6.1	Manage the captive breeding program to meet program needs until termination Responsibility: ZV	<p>The purpose of the captive breeding program has been to insure against catastrophic loss in reintroduction populations, to be a source of animals for reintroductions, to provide opportunities for research, and to provide ambassador animals. With the success of introduced populations across the landscape and likely establishment of additional large populations at French Island and Tiverton, it is envisaged that risk of catastrophic loss will have been removed.</p> <p>It is expected that the resource intensive captive breeding program will no longer be needed within 5 years.</p> <p>The captive breeding program to be maintained until termination as a source of animals for introductions, with adequate breeding managed to promote genetic diversity within the program and in the meta-population.</p> <p>The captive breeding program will be reviewed annually to ensure that the reintroduction requirements are met.</p> <p>A final review to be undertaken to make a determination of when the reintroduction needs have been met and risk of catastrophic loss has been averted, and the captive program will be terminated.</p>	<p>Captive insurance population maintained with suitable founders for releases as required.</p> <p>Agreed trigger for termination of captive breeding program developed. Captive breeding program terminated when trigger is reached.</p>
6.2	Maintain ambassador animals Responsibility: ZV	A number of ambassador animals to be maintained by Zoos Victoria beyond the termination of the captive breeding program to assist in community and school engagement and fundraising efforts.	Ambassador animals maintained.

Objective: Increase population size

Specific Objective 7: Research into establishing and maintaining bandicoot populations

Key Performance Criterion:

All identified high priority research implemented

Table 10 Specific Objective 7: Research into establishing and maintaining bandicoot populations

Action No.	Action Description	Action Details	Performance criteria
7.1	Identify and undertake priority research projects Responsibility: Recovery Team	To combat Eastern Barred Bandicoot's lack of natural evasion techniques for cat predatory behaviour, bandicoots to be trained in predator aversion and research to be carried out to determine if this contributes to reintroduction success. The survival and reproductive success of animals translocated into established populations to be evaluated. A trial of guardian dogs to be undertaken at 3 unfenced reintroduction sites, to determine success in the presence of foxes and/or cats. The relationship between habitat quality and bandicoot population growth to be explored.	Critical knowledge gaps identified and successfully addressed.

Objective: Increase population size

Specific Objective 8: Maintain and/or enhance community and agency engagement and support

Key Performance Criterion:

Community and agency support enhanced

Table 11 Specific Objective 8: Maintain and/or enhance community and agency engagement and support

Action No.	Action Description	Action Details	Performance criteria
8.1	Increase recognition and support for the Eastern Barred Bandicoot recovery program. Responsibility: Recovery Team	The recovery team has had a very successful engagement program, with the production of a newsletter, the recent success of the crowdfunding campaign to enhance the genetic viability, education through visitation opportunities at Mount Rothwell, Hamilton,	Ongoing institutional, Indigenous and specific other community support secured.

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Action No.	Action Description	Action Details	Performance criteria
		Woodlands and Zoos Victoria, and media interest in programs such as the guardian dog trial. The recovery team to continue to build the profile of the recovery program through engagement with targeted local communities and the general public. The recovery team to also work to ensure that communications and engagement activities undertaken across various support agencies is coordinated. Opportunities to expand the profile of the species in the media to be undertaken. The recovery team to ensure that opportunities to engage with Traditional Owners are taken whenever possible, and support of Indigenous communities will be a continual part of the recovery program.	

ZV: Zoos Victoria, PV: Parks Victoria, PINP: Phillip Island Nature Park.

Priority, Feasibility, Duration and Estimated Costs of Recovery Actions*

Table 12 Priority, Feasibility, Duration and Estimated Costs of Recovery Actions

Specific Objective/ Action	Description	Priority 3 = high 1 = low	Feasibility 3 = high 1 = low	Action weighting Priority + feasibility	Cost estimate Year 1	Cost estimate Year 2	Cost estimate Year 3	Cost estimate Year 4	Cost estimate Year 5	Cost estimate Total
1	Support the existing three reintroduction sites and three introduction sites	–	–	–	–	–	–	–	–	–
1.1	Maintain reintroduction sites free of exotic predators	3	3	6	60,000	60,000	60,000	60,000	60,000	300,000
1.2	Optimise habitat conditions for EBBs	3	2	5	30,000	30,000	30,000	30,000	30,000	150,000
1.3	Monitor EBB population	3	3	6	10,000	10,000	10,000	10,000	10,000	50,000
1.4	Develop triggers for management intervention at all sites	2	3	5	5,000	–	–	–	–	5,000
2	Establish one new reintroduction site within the original range	–	–	–	–	–	–	–	–	–
2.1	Maintain fence at Tiverton	3	3	6	30,000	30,000	30,000	30,000	30,000	150,000
2.2	Remove and maintain as feral predator free	3	3	6	25,000	5,000	5,000	5,000	5,000	45,000
2.3	Control rabbits and native herbivores	3	3	6	5,000	5,000	5,000	5,000	5,000	25,000
2.4	Control environmental weeds	2	2	4	10,000	10,000	10,000	10,000	10,000	50,000

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Specific Objective/ Action	Description	Priority 3 = high 1 = low	Feasibility 3 = high 1 = low	Action weighting Priority + feasibility	Cost estimate Year 1	Cost estimate Year 2	Cost estimate Year 3	Cost estimate Year 4	Cost estimate Year 5	Cost estimate Total
2.5	Prepare and implement the reintroduction of an EBB population into the new site	3	3	6	5,000	0	0	0	0	5,000
2.6	Once EBB population is established implement actions in line with established sites	3	3	6	30,000	30,000	30,000	30,000	30,000	150,000
3	Establish at least two self-sustaining island populations	–	–	–	–	–	–	–	–	–
3.1	Control and monitor exotic predators	3	2	5	65,000	65,000	65,000	65,000	65,000	325,000
3.2	Gain landholder and licencing permission	3	2	5	10,000	10,000	0	0	0	20,000
3.3	Prepare and implement the reintroduction of an EBB population into the new site	3	2	5	20,000	20,000	0	0	0	40,000
3.4	Once EBB population is established implement actions in line with established sites	3	3	6	0	5,000	5,000	5,000	5,000	20,000
4	Increase population size to maintain genetic variation	–	–	–	–	–	–	–	–	–
4.1	Maximise population size at all sites	3	2	5	n/a**	n/a	n/a	n/a	n/a	–
4.2	Monitor genetic diversity in populations	3	3	6	5,000	5,000	5,000	5,000	5,000	25,000
4.3	Institute meta-population management	3	2	5	5,000	5,000	5,000	5,000	5,000	25,000
5	Research, and if successful, introduce outbred	–	–	–	–	–	–	–	–	–

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Specific Objective/ Action	Description	Priority 3 = high 1 = low	Feasibility 3 = high 1 = low	Action weighting Priority + feasibility	Cost estimate Year 1	Cost estimate Year 2	Cost estimate Year 3	Cost estimate Year 4	Cost estimate Year 5	Cost estimate Total
	individuals to all established and new sites									
5.1	Develop strategy and establish site with outbred individuals	3	3	6	10,000	0	0	0	0	10,000
5.2	Introduce outbred individuals to all established and new sites	3	2	5	0	25,000	25,000	0	0	50,000
5.3	Monitor genetic diversity across sites to ensure uptake of Tasmanian genes	3	2	5	0*	0	0	0	0	
6	Phase out the captive breeding program when no longer required	–	–	–	–	–	–	–	–	–
6.1	Manage the captive breeding program to meet program needs	3	3	6	250,000	250,000	250,000	250,000	250,000	1,250,000
6.2	Maintain ambassador animals	2	3	5	–	–	–	–	–	–
7	Research into establishing and maintaining bandicoot populations	–	–	–	–	–	–	–	–	–
7.1	Identify and undertake priority research projects	3	2	5	50,000	50,000	50,000	50,000	50,000	250,000
8	Maintain and/or enhance community and agency engagement and support	–	–	–	–	–	–	–	–	–
8.1	Increase recognition and support for the Eastern Barred Bandicoot recovery program.	3	2	5	20,000	20,000	20,000	20,000	20,000	100,000

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Specific Objective/ Action	Description	Priority 3 = high 1 = low	Feasibility 3 = high 1 = low	Action weighting Priority + feasibility	Cost estimate Year 1	Cost estimate Year 2	Cost estimate Year 3	Cost estimate Year 4	Cost estimate Year 5	Cost estimate Total
TOTAL	–	–	–	–	645,000	635,000	605,000	580,000	580,000	3,045,000

* Cost estimates have been calculated for the first 5 years of the recovery plan. Costings will be reviewed after this 5 year period.

** Costs covered by other actions.

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Appendix A: Nationally threatened flora and fauna that may benefit from the recovery plan

The tables below show nationally threatened flora and fauna listed under the EPBC Act that occur in western basalt plains grasslands or targeted fox-free islands and that may benefit from actions arising from this Recovery Plan.

Table 13 Mammals

Species	Common Name	Status (EPBC Act)
<i>Potorous tridactylus</i>	Long-nosed Potoroo	Vulnerable
<i>Dasyurus viverrinus</i>	Eastern Quoll	Endangered

Table 14 Birds

Species	Common Name	Status (EPBC Act)
<i>Numenius madagascariensis</i>	Eastern Curlew	Critically endangered
<i>Sternula nereis nereis</i>	Fairy Tern	Vulnerable
<i>Thinornis cucullatus</i>	Hooded Plover	Vulnerable

Table 15 Reptiles

Species	Common Name	Status (EPBC Act)
<i>Delma impar</i>	Striped Legless Lizard	Vulnerable
<i>Eulamprus tympanum marnieae</i>	Corangamite Water Skink	Endangered
<i>Tympanocryptis pinguicolla</i>	Grassland Earless Dragon	Endangered

Table 16 Insects

Species	Common Name	Status (EPBC Act)
<i>Synemon plana</i>	Golden Sun Moth	Critically Endangered

Table 17 Plants

Species	Common Name	Status (EPBC Act)
<i>Lachnagrostis adamsonii</i>	Adamson's Blown-grass	Endangered
<i>Cullen parvum</i>	Small Scurf-pea	Endangered
<i>Diuris basaltica</i>	Basalt Golden Moths	Endangered
<i>Diuris fragrantissima</i>	Sunshine Diuris	Endangered
<i>Dodonaea procumbens</i>	Trailing Hop-bush	Vulnerable
<i>Glycine latrobeana</i>	Clover Glycine	Vulnerable
<i>Lepidium aschersonii</i>	Spiny Pepper-cress	Vulnerable
<i>Lepidium hyssopifolium</i>	Basalt Pepper-cress	Endangered
<i>Leucochrysum albicans subsp. tricolor</i>	Hoary Sunray	Endangered
<i>Caladenia ornata</i>	Ornate Pink Fingers	Vulnerable
<i>Pimelea spinescens subsp. spinescens</i>	Plains Rice-flower	Critically Endangered

Species	Common Name	Status (EPBC Act)
<i>Prasophyllum diversiflorum</i>	Gorae Leek-orchid	Endangered
<i>Prasophyllum frenchii</i>	Maroon Leek-orchid	Endangered
<i>Prasophyllum suaveolens</i>	Fragrant Leek-orchid	Endangered
<i>Pterostylis basaltica</i>	Basalt Greenhood	Endangered
<i>Rutidosis leptorhynchoides</i>	Button Wrinklewort	Endangered
<i>Senecio macrocarpus</i>	Large-fruit Groundsel	Vulnerable
<i>Senecio psilocarpus</i>	Swamp Fireweed	Vulnerable
<i>Xerochrysum palustre</i>	Swamp Everlasting	Vulnerable

Appendix B: Evaluation of achievements against specific objectives in 2010 Eastern Barred Bandicoot Recovery Program

Table 18 below shows an evaluation of achievements against specific objectives in 2010 Eastern Barred Bandicoot Recovery Program as at 2021.

Table 18 Evaluation of achievements against first objective of the 2010 Eastern Barred Bandicoot Recovery Program, as at 2021

Objective and Associated Actions	Description	Comments	Degree of Completion
Objective	Establish self-sustaining reintroduced populations totalling 1000 individuals	Total population size at established sites (Hamilton, Churchill, Woodlands and Mt Rothwell) varies between 550 and 1700 depending on seasonal conditions and grazing management. Additional animals present within the captive program and at the establishing population on Phillip Island.	Complete
Action	Establish minimum population targets for reintroduced populations.	Density estimates now produced for 3 sites allow us to predict population sizes at sites and report against the recovery objective for population size.	Complete
Action	Manage releases and translocations to meet site-specific population targets.	Increased confidence in population estimates from monitoring produced using a combination of distance sampling and cage trap methods. Estimates in population size are produced regularly for all sites.	Complete
Action	Monitor and exclude foxes and cats at each reintroduction site.	Reintroduction sites were maintained sufficiently free of foxes that populations were not impacted by predation.	Complete
Action	Monitor and manage habitat at all reintroduction sites.	Environmental weeds are controlled at all 3 reintroduction sites. Native and feral	Complete

Objective and Associated Actions	Description	Comments	Degree of Completion
		herbivores are managed to limit total grazing pressure and minimise any impacts on EBB habitat quality.	
Action	Reintroduce Eastern Barred Bandicoots to Woodlands Historic Park.	Successfully re-established in 2013 and subsequently seriously impacted by macropod grazing; macropod grazing is now managed and Eastern Barred Bandicoots are re-established across the entire site.	Complete
Action	Investigate (and if agreed implement) a release of Eastern Barred Bandicoots onto French Island.	Trial release on French Island conducted in 2013 provided evidence of likelihood of success. Released on French Island in 2019.	Largely complete
Action	Establish a large fox-free reintroduction site in south-west Victoria.	1000 ha Tiverton private reserve: feral fence completed in 2017. Release planned once free of foxes and cats. Likely population size of 1-2000 individuals.	Partially complete

Table 19 Evaluation of achievements against second objective of the 2010 Eastern Barred Bandicoot Recovery Program, as at 2021

Objective and Associated Actions	Description	Comments	Degree of Completion
Objective	Manage the sub-species to minimise any further loss of genetic diversity	–	Largely complete
Action	Prevent further loss of genetic diversity	Total population size increased rapidly to more than 1000 individuals. All populations linked by translocations to maximise effective population size (Weeks <i>et al.</i> 2013). Gene-pool mixing trial completed in 2019. Outbred animals to be released across all populations over next 10 years.	Largely complete
Action	Manage captive population to provide a secure insurance population and to provide required number of Eastern Barred Bandicoots for release.	Program reviewed, new targets set, increase in number of breeding pairs to 15, a number of research projects aimed to increase breeding success and establishment success of captive bred animals. Animals suitable for translocation	Largely complete

Objective and Associated Actions	Description	Comments	Degree of Completion
		have been produced each year to assist establishment of new and supplementation of existing populations.	

Table 20 Evaluation of achievements against third objective of the 2010 Eastern Barred Bandicoot Recovery Program, as at 2021

Objective and Associated Actions	Description	Comments	Degree of Completion
Objective	Objective 3: Undertake community education and communication for the recovery program	–	Largely complete
Action	–	Recovery team meets twice yearly, and subgroups as necessary. An annual review is carried out in June, reporting on progress against annual action priorities, and reviewing and agreeing on priorities for the coming year. A recovery team publication was produced at least once per year. A communications strategy was produced to align messaging by recovery team member organisations. The EBB program achieved a high profile at state level and nationally.	Largely complete