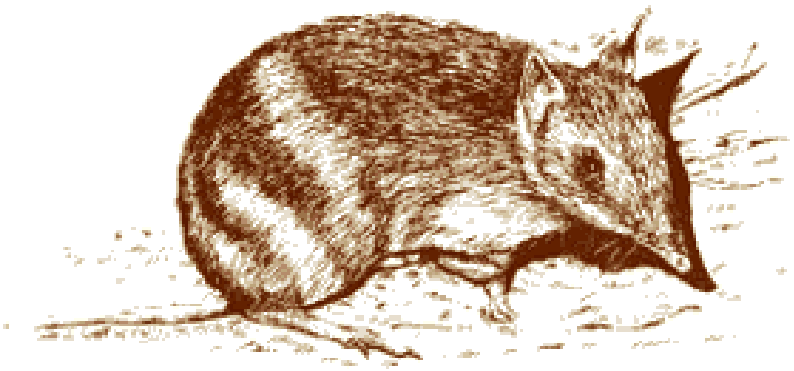
National Recovery Plan for the Eastern Barred Bandicoot (mainland) *Perameles gunnii* unnamed subspecies

Richard Hill, Amy Winnard and Mandy Watson



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This Recovery Plan has been developed with the involvement and cooperation of a range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

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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 recognised as distinct subspecies, although these have not been formally named. The original wild population of the mainland subspecies is presumed extinct, and now survives in three reintroduced populations collectively comprising c. 150–250 animals, and a captive population of 50 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 subspecies is listed as Endangered under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and Threatened under the Victorian *Flora and Fauna Guarantee Act* 1988 (FFG Act). This revised national Recovery Plan for the mainland subspecies of the Eastern Barred Bandicoot builds on previous plans for the subspecies (Backhouse 1992, Watson & Halley 2000), and details its distribution and biology, conservation status, threats, and recovery objectives and actions to ensure its long-term survival.

Species Information

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 three or four pale bars on the hindquarters (Brown 1989; Seebeck 1979). The Tasmanian and mainland forms are considered to be different at the subspecies level (Robinson *et al.* 1993), although this has not been reflected in any formal taxonomic designation.

The species is short-lived and generally survives only 2–3 years in the wild, but is highly fecund. Gestation lasts 12–13 days, with litters of 1–5 young (average 2–3) being produced. Young bandicoots remain in the pouch for 55 days, and three months after birth they become independent and disperse. Females may breed from four 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 late summer, and may cease altogether during times of drought. In favourable conditions, a single female can produce up to five litters a year (Seebeck 1979).

Eastern Barred Bandicoots 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). Densities range 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). 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.

The Eastern Barred Bandicoot feeds largely on invertebrates and is primarily insectivorous; its diet includes beetles, crickets, grasshoppers, moths and earthworms (Brown 1989, Dufty 1994, Hannan 1994; Cook 2001). Some plant material including bulbs of onion-grass *Romulea rosea* and orchard fruit is also eaten (Brown 1989; Dufty 1991). In Tasmania, hypogeal and gasteromycete sporocarps from hypogeal fungi were regularly eaten (Mallick *et al.* 1997; Quinn 1985; Reimer & Hindell 1996). Invertebrate prey items preferred by Eastern Barred Bandicoots were more common when trees and shrubs were present (Cook 2001).

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 about three million ha (Figure 1: Seebeck 1979; Brown 1989; Kemper 1990). The original wild population is now extinct. Reintroductions have been attempted at several locations within its former range in south-western Victoria, and three reintroduced populations still survive. Within Victoria, the range is encompassed by the Victorian Volcanic Plains IBRA bioregion (*sensu* DEH 2000).

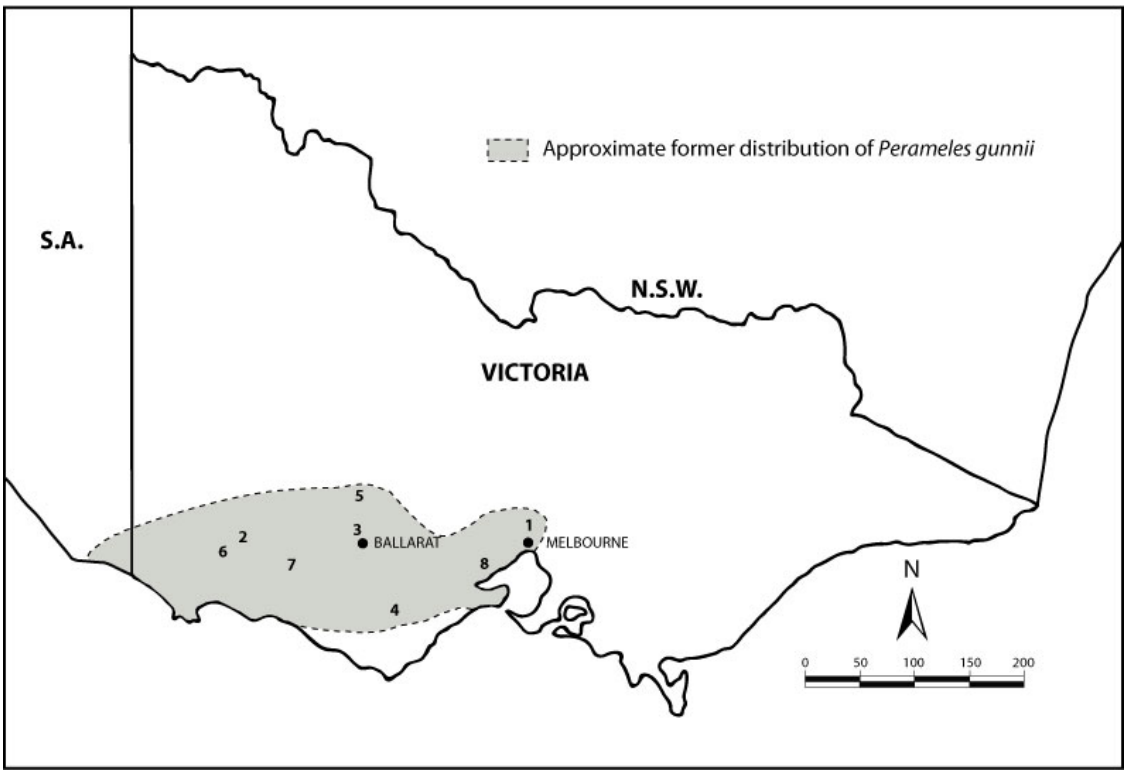

Figure 1. Former distribution of *Perameles gunnii* and location of reintroduction sites.

Extant populations: 2 – Hamilton Community Parklands; 3 – Mooramong; 8 – Mt Rothwell

Unsuccessful reintroductions: 1 – Woodlands Historic Park; 4 – Floating Islands Nature Reserve; 5 – Lake Goldsmith Wildlife Reserve; 6 – Lanark; 7 – Cobra Killuc Wildlife Reserve

Habitat

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 1994; Seebeck 1979). There are historical records from South Australia of the species 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; areas often dominated by weed species such as European gorse *Ulex europaeus* and spiny rush *Juncus acutus* (Brown 1989; Dufty 1994). Bandicoots tended to forage in sites with uncompacted, acidic soils, high ground cover and tall grasses (Dufty 1991). Bandicoots were rarely observed foraging more than 20 m away from thick cover and were not trapped further than 60 m from nearby shelter (Dufty 1994). Bandicoots constructed grass-lined nests within a range of natural and artificial locations including introduced shrubs, culverts, car tyres and steel guttering, and also used man-made bandicoot shelters (Dufty 1994).

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 *Acacia mearnsii*, *Acacia paradoxa* and *Acacia salicina*, along with *Themeda triandra* and four 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 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).

Population Information

The last remaining wild population of the mainland Eastern Barred Bandicoot occurred in and around the city of Hamilton in south-western Victoria. The last confirmed sighting was in 2002; this population is now considered extinct. Attempts have been made to establish reintroduced populations of the species at eight sites within its former range (Figure 1), of which three currently have extant populations (July 2010).

Captive Population

A captive population of Eastern Barred Bandicoots was established in 1988 to provide some genetic insurance for the taxon and to breed animals for reintroduction. Forty animals were collected from the wild at Hamilton to form the basis of a captive breeding population (Weeks 2010). Subsequent analyses suggest that only 19 of these individuals bred successfully, thus becoming the founders for the entire wild and captive populations. The captive population currently consists of 7 breeding pairs that can produce between 9 – 12 animals per pair per year (July 2010).

Extant wild populations

Hamilton Community Parklands

The Hamilton Community Parklands on the northern perimeter of Hamilton contains an area of 100 ha of plains grassy woodland enclosed by a 1.8 m high electrified predator barrier fence. Over 120 bandicoots were released into the reserve between 1989 and 2003 (Winnard & Coulson 2008). The population reached a maximum during 1993, but declined markedly and was presumed extinct in 2005. The fence was ineffective at excluding foxes and in 2005 it was upgraded and all foxes were removed. Thirty bandicoots were released into the fox-free reserve in 2007 and the population now occupies the entire reserve with an estimated 60-80 animals.

Mooramong

Mooramong is a 1,500 ha farming property 170 km west of Melbourne, owned and managed by the National Trust of Australia (Victoria). Within the property is a 200 ha nature reserve (130 ha of wetlands, 70 ha of grassland and shrubland) that has stock-proof fences but not predator barrier fences. Between 1992 and 1995, 85 bandicoots were released into the reserve, and quickly became established, with breeding and recruitment regularly observed (Winnard & Coulson 2008). The population declined in the late 1990s, possibly due to severe drought conditions. No bandicoots have been trapped since 2008 but bandicoots are still present in low numbers (March 2010). An extensive predator control program is maintained on the property. Carrying capacity is estimated to be about 30 individuals (Robley et al. 2004). Despite the extensive fox control program the primary factor limiting population size at this site is considered to be predation by foxes (Winnard unpubl. Data, DSE, 2010).

Mount Rothwell

Mount Rothwell (situated 60 km south-west of Melbourne) is a 400 ha reserve of open grassy woodlands and grasslands surrounded by an electrified predator barrier fence. The site has remained fox free since the fence was completed in 2002. Thirty bandicoots were released there between 2004 and 2009. Until 2008 the reserve was overgrazed by macropods causing a marked decline in cover, but this has now been controlled and there has been a marked recovery in vegetation condition. The site can only be monitored by surveillance cameras due to the presence of a number of non-target species which makes trapping Eastern Barred Bandicoots difficult. In November 2009, Eastern Barred Bandicoots were found at 14 of 16 points across the reserve. Eastern Barred Bandicoots are now considered common to very common across the reserve and the total population is conservatively estimated to be 100 - 200 individuals (July 2010) (R Hill pers.comm., DSE).

Unsuccessful reintroductions

Woodlands Historic Park

Woodlands Historic Park is a 300 ha reserve of open grassy woodland enclosed by a 1.8 m high electrified fence. The first release there was in 1989, and a total of 174 captive-bred animals were released up to 2004 (Winnard & Coulson 2008). The population established and expanded quickly. In 1994/5 it reached an estimated 600 bandicoots across the reserve (Winnard & Coulson 2008). The population then declined markedly, due to a combination of predation by foxes, drought, overgrazing by kangaroos and rabbits, and the removal of some 100 bandicoots for translocation to other sites (Watson & Halley 2000). The last bandicoot caught at Woodlands was in 2005 and this population is now considered extinct.

Lake Goldsmith Wildlife Reserve

Lake Goldsmith Wildlife Reserve, 50 km west of Ballarat, is 870 ha in area and includes 150 ha of unfenced grassland vegetation. Fifty bandicoots were released there between 1994 and 1998 (Winnard & Coulson 2008). This population rarely had a positive rate of increase with a carrying capacity of about 20 individuals (Robley *et al.* 2004). The population declined during the early part of 1998, most likely as a result of drought and predation. The last bandicoot caught there was in 2005 (Winnard & Coulson 2008) and this population is now considered extinct.

Lanark

Lanark is a privately-owned 800 ha farm 30 km south-west of Hamilton. It comprises 63 ha of seasonal and permanent wetlands and 48 ha of revegetated shelterbelts and bush blocks, while the remainder is open paddocks running sheep and stands of timber for commercial tree farming. A total of 63 bandicoots were released at Lanark between 1994 and 2002 (Winnard & Coulson 2008). Initial trapping results indicated good reproduction and recruitment, however, by 2003 the population had declined markedly, due to a combination of drought and a reduction in predator control efforts. No bandicoots or their foraging digs have been observed at Lanark since 2005 and this population is now considered extinct (Winnard & Coulson 2008).

Floating Islands Nature Reserve

Floating Islands Nature Reserve is a 85 ha reserve 20 km west of Colac managed by Parks Victoria. The reserve comprises a mosaic of open grasslands and dense shrublands and woodlands on stony basalt rises interspersed with swampy depressions. Fifty bandicoots were released there between 1994 and 1996 (Winnard & Coulson 2008). Breeding did occur, but by 1999 the population was considered extinct, most likely due to predation (Winnard & Coulson 2008).

Cobra Killuc Wildlife Reserve

Cobra Killuc Wildlife Reserve is a reserve of 500 ha of grassland and grassy woodland. A total of 103 bandicoots were released between 1997 and 1999, but a combination of predation and drought are thought to have caused the population to decline to extinction by 2002 (Winnard & Coulson 2008).

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 (Brown 1989). By 1972, the Eastern Barred Bandicoot had become extinct throughout its mainland range, except for a small population surviving in the vicinity of the City of Hamilton in western Victoria (Seebeck 1979; Brown 1989). At that time the Hamilton population occurred over about 3,000 ha, with perhaps over 1,000 individuals present. The area occupied declined to about 1,400 ha by 1985 and to about 600 ha by 1988. 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 last confirmed sighting of an individual of this population was in 2002, and it is now considered extinct in the wild. The Tasmanian subspecies is still widely distributed although it has suffered a reduction in numbers, primarily through loss of habitat, and is still declining in some areas (Mallick *et al.* 1997).

The main threats to the Eastern Barred Bandicoot are summarised as follows:

Introduced Predators

Red Foxes are considered 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). Control of predators is considered a key requirement for the successful reintroduction of Eastern Barred Bandicoots (Watson & Halley 2000). Foxes were present at all five reintroduction sites where populations have now become extinct. One site, Woodlands Historic Park, did have a predator barrier fence but this fence was ineffective at excluding all foxes (Winnard & Coulson 2008). If fox control is continuous and intensive, then Eastern Barred Bandicoot populations may persist in the presence of foxes. However, populations large enough to contribute to the Eastern Barred Bandicoots conservation population targets have not been established using this approach. The current recovery model now concentrates on exclusion of foxes from translocation sites.

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. Recent evidence of this comes from Hamilton Community Parklands. Three cats were detected and destroyed within this reserve over a two year period. Quarterly monitoring during this period did not detect a decline in the population size or the number of recruits (A. Winnard, unpubl. Data, 2010).

Drought and Climate Change

The effect of drought on Eastern Barred Bandicoot populations is not fully understood. Prolonged drought/below average rainfall in western Victoria occurred between 1997 and 2008. At four reintroduction sites, Woodlands Historic Park, Hamilton Community Parklands, Lake Goldsmith and Lanark, total population size declined significantly during the 1997-2002 drought. All four of these sites experienced problems in maintaining effective predator control. The ongoing drought is thought to have reduced vegetation cover, impacting on the availability of bandicoot nesting and shelter sites, and making them more susceptible to predation. Reintroduction results indicate that the cumulative impacts of fox predation and drought significantly elevate the likelihood of local extinction.

At predator-free reintroduction sites Eastern Barred Bandicoots appear much more drought tolerant. For example Eastern Barred Bandicoots continued to expand their range and numbers at Mt Rothwell through a period of below-average rainfall (Hill unpubl. data, 2009).

Habitat Loss or Modification

Over 99% of Victoria's native grasslands and grassy woodlands within the Eastern Barred Bandicoot range have been destroyed or degraded (Scarlett *et al.* 1992). The ecological community 'Natural Temperate Grassland of the Victorian Volcanic Plain', that encompasses the Victorian distribution and habitat of the Eastern Barred Bandicoot, is listed under the EPBC Act as a critically endangered ecological community.

Habitat complexity is an important component of Eastern Barred Bandicoot habitat (Cook 2001; Dufty 1991, 1994) and lack of habitat heterogeneity was considered to limit the area of potential habitat for the bandicoot's recovery in Hamilton (Cook 2001; Dufty 1994). Recommendations for habitat management and identification of suitable habitat focus on creating a structurally heterogeneous mosaic of feeding areas and dense cover to provide shelter from predators (Dufty 1994; Reading *et al.* 1996). However, in the absence of predators, habitat complexity appears less important (Winnard 2010).

Current State of Knowledge

Mooramong provides an example of the effectiveness of broad-scale fox control at an unfenced site. There an unfenced reintroduced population of Eastern Barred Bandicoots has persisted for 18 years due to an integrated predator control program across 1500 ha of the property. This site has an estimated carrying capacity of about 30 individuals, but has recently declined to untrappable densities. Demographic analyses indicate that population size here is limited by predation (Winnard 2010).

Unsuccessful reintroduction attempts at five sites all experienced the same fundamental problem – foxes could not be excluded (Winnard & Coulson 2008). In addition the largest population declines occurred during extensive drought periods. One site also had a problem with severe overgrazing by Eastern Grey Kangaroos. Overgrazing and drought conditions both caused a reduction in vegetation cover that removed bandicoot shelter sites, making them more vulnerable to fox predation. From this important knowledge has been acquired and incorporated into revised recovery strategies for this species. The first is that foxes are the most important predator of Eastern Barred Bandicoots and reintroduction sites which exclude foxes altogether are the most likely to successfully establish self-sustaining populations of Eastern Barred Bandicoots. Also, kangaroo populations within fenced enclosures must be regulated to prevent overgrazing. The recovery program is now focusing on the establishment of large fox-free reserves to establish large self-sustaining populations which can persist during unfavourable conditions such as drought.

Previous versions of the recovery plan aimed to establish viable populations in unfenced sites where predator control was undertaken. Experience from reintroduction sites indicates that sustainable populations of bandicoots cannot currently be established in the presence of foxes and this model for recovery is now a low priority. Future reintroduction to unfenced sites would require a significant improvement in the effectiveness of fox control methods or an increase in bandicoot survival in the presence of foxes (e.g. through predator avoidance training). A full review of the causes of failure of previous reintroductions is provided in Winnard and Coulson (2008). These authors concluded that drought, habitat loss and predation were the underlying causes of extinction at reintroduction sites.

There has been considerable loss of genetic diversity within the mainland population of Eastern Barred Bandicoots over the past 30 years (c. 30-40%, Weeks 2010). The Eastern Barred Bandicoot Recovery Team has identified an urgent need to increase in total population size to minimise any further loss of genetic diversity. In a review of the Eastern Barred Bandicoots program in 2007, which included several experts external to the recovery program, an interim population target for the 5-year lifetime of this recovery plan was set at 1000 individuals and an overall population size for recovery was set at 2500 animals based on the recommendations of Reading *et al*. (1996). Weeks (2010) made a number of recommendations for Eastern Barred Bandicoots genetic conservation management. Genetic conservation is now the highest priority management objective for Eastern Barred Bandicoots.

During the past three years, the Recovery Team has demonstrated a successful model for recovery, establishing bandicoot populations in two fox-free areas totalling 500 ha in area at Mt Rothwell and Hamilton Parklands. At both sites, population densities have reached an estimated density of one animal per 1-1.5ha of suitable habitat. The Recovery Team is in the process of identifying other suitable introduction or reintroduction sites for fencing to exclude foxes.

Increasing the total population size of the Eastern Barred Bandicoots is the highest priority of the recovery program. Based on a projected density of one animal per 1.5 ha, approximately 1500 ha of fox-free suitable habitat is required to establish a population of 1000 Eastern Barred Bandicoots. A further 2250 ha of additional fox-free suitable habitat is required to reach the current long-term objective of 2500 animals.

Achieving this population recovery in south-west Victoria will be very expensive, requiring the acquisition, predator fencing and ongoing management of c. 4000 ha of suitable Eastern Barred Bandicoot habitat. For this reason, the recovery team is investigating introducing Eastern Barred Bandicoots on to large fox-free islands, such as French Island, which are outside of the historic range of the Eastern Barred Bandicoot, but which may offer the only practicable way to achieve the rapid increase in population size which is necessary for recovery of this taxon.

The recovery program has a successful captive breeding program, resulting in good recovery potential for the subspecies at sites supporting suitable habitat and lacking foxes. Careful selection of breeding animals has minimised loss of genetic diversity but this breeding population is now being increased to manage genetic diversity better (July 2010).

Recovery Information

Management of reintroduced populations

Predator exclusion from reintroduction sites is currently the most important management action. The only two sites (Hamilton and Mt Rothwell) that currently (July 2010) support significant numbers of Eastern Barred Bandicoots are both fox free. Regular fence monitoring and maintenance have ensured that they are effective at excluding foxes. A third site, Woodlands Historic Park, is currently being made fox free (July 2010).

Grazing by kangaroos and rabbits can become an important management issue, particularly at fenced sites where captive populations of kangaroos can reach very high densities. At reintroduction sites macropod populations must strictly managed to prevent reductions in Eastern Barred Bandicoot habitat quality.

Recovery strategies for Eastern Barred Bandicoots are now focused upon reintroductions into large fox-free areas. Management practices that may hamper population recovery and long-term viability include reduction in predator monitoring and control within fenced enclosures, and reductions in regular fence monitoring and maintenance.

Captive Management

Zoos Victoria are currently in the process of increasing their capacity to house Eastern Barred Bandicoots at Werribee Open Range Zoo (WORZ), and are planning to initiate research projects investigating methods for increasing the fitness of captive-bred bandicoots. Thirty-six new holding enclosures for Eastern Barred Bandicoots will be constructed at WORZ, increasing the breeding capacity of the captive population. Bandicoots need to be housed individually and available holding space has constrained the breeding program in some years. When no releases are planned for the year, captive institutions have to accommodate all young produced. Additional holding facilities are currently being investigated and developed to manage this issue better (July 2010). Thus far, Mt Rothwell,

Serendip Sanctuary, Mooramong and Mt Sturgeon at Dunkeld have been identified as potential holding sites.

To maintain levels of genetic diversity all sites, both captive and wild populations. will be managed as a meta-population This will require shifting individuals between populations each generation.

Island Introduction

All reintroduction sites to date have been relatively small in area (≤400 ha) and a much larger site is needed to support the several thousand animals required for long-term recovery. French Island is a 18,000 ha fox-free island in Westernport Bay, 50 km south-east of central Melbourne, Victoria. French Island has an estimated 9,000 ha of suitable habitat for Eastern Barred Bandicoots.

French Island is outside the historical range of the Eastern Barred Bandicoot, so any release will be an introduction. The Recovery Team is planning to conduct a trial release on French island to investigate the habitat choices and diet of non-breeding bandicoots. The results of this would be used to evaluate the potential for successful release of Eastern Barred Bandicoots onto French Island. If the trial is successful, permission will need to be sought from residents of French Island prior to any further release.

Benefits to other Species/Ecological Communities

The Eastern Barred Bandicoot is one of many species of threatened fauna and flora occurring in the Volcanic Plains of south-western Victoria. The grasslands and grassy woodlands of the Victorian Volcanic Plains are listed as threatened under both Commonwealth and State legislation ('Natural Temperate Grassland of the Victorian Volcanic Plain' - Critically Endangered, EPBC Act, 'Western (Basalt) Plains Grasslands Community' and 'Western Basalt Plains (River Red Gum) Grassy Woodland Floristic Community' - FFG Act). The Eastern Barred Bandicoot is a flagship for biodiversity conservation of the western basalt plains. Conservation actions for the bandicoot will assist conservation of other threatened species and communities found in grassland and grassy woodland habitats (Appendix 1).

Habitat management requirements for the Eastern Barred Bandicoot are compatible with those for co-occurring native species (e.g. burning regimes and pest plant and animal control). The only potentially negative impacts envisaged are restricted to exotic non-target species (i.e. domestic dogs and cats) that may consume poison baits used to control foxes should they be allowed to roam release sites unrestrained. Native non-target species identified as potentially at risk from consuming poison baits do not occur in areas managed for Eastern Barred Bandicoots. Notably, large fox-free exclosures for Eastern Barred Bandicoots could provide benefits for other threatened fauna, such as the Eastern Quoll and Rufous Bettong.

Affected Interests

The following table contains a list of organisations and persons affected by this plan:

Organisation	**Role/Involvement**
Department of Sustainability and Environment, Victoria	Managing recovery program, Convenor of Recovery Team
Zoos Victoria	Captive breeding and release of bandicoots
Parks Victoria	Land manager of Woodlands Historic Park reintroduction site

Organisation	Role/Involvement
East View Valley Pty Ltd	Owners of Mount Rothwell reintroduction site
Hamilton Community Parklands Committee	Manager of Hamilton Community Parklands reintroduction site
National Trust	Owners of the 'Mooramong' property reintroduction site
Conservation Volunteers Australia	Managing implementation of Eastern Barred Bandicoot program at Woodlands.

Role and Interests of Indigenous People

Indigenous communities representing the Gunditj Mara on whose traditional lands the species still occurs were consulted during the development of this Recovery Plan. Opportunities to involve indigenous communities in implementation of the Recovery Plan are being explored.

Social and Economic Impacts

Successful re-introductions of Eastern Barred Bandicoots on private farming land assists rural nature conservation by promoting sustainable farm management practices and demonstrating that direct contributions to conservation can be made by the community. The protection of remnant habitat (especially endangered native grasslands and grassy woodland communities), the provision of shelter belts of native trees and shrubs and the protection or provision of wetland areas on farms provide direct benefits to native species and communities and to primary production. In addition, control of predators can provide benefits such as improved lambing percentages in areas where sheep farming occurs. These benefits can all be promoted through the Eastern Barred Bandicoot recovery program.

A potential adverse economic impact that may result from implementation of the plan is the ongoing cost to land managers of intensive and sustained predator control, necessary to support reintroduced populations of the Eastern Barred Bandicoot. However other benefits, such as increased productivity, can extend to land managers from this work.

Management Practices

Predator control is a major focus of recovery effort. Two reintroduction sites are surrounded by predator-barrier fences. At all reintroduction sites there are comprehensive integrated predator control programs. These programs are supported by Department of Sustainability and Environment, Parks Victoria, industry sponsorship, Catchment Management Authorities, National Trust, and Field and Game volunteers. Continued funding of these programs is essential for the viability of reintroduced populations.

Management of fire and grazing by kangaroos are important issues particularly at fenced sites. Kangaroo densities have reached very high levels at Woodlands Historic Park in the past and caused major reductions in vegetation cover within bandicoot habitats. This was thought to contribute significantly to a major population decline of bandicoots at Woodlands in the 1990s.

Existing and potential Eastern Barred Bandicoot habitats on private land in the Southern Grampians Shire are given additional protection through an Environment Significance Overlay. This shire also runs community education programs promoting responsible cat ownership.

Management practices that may hamper viability and recovery include reduction in predator control efforts at reintroduction sites, legislative controls on the use of poison baits for fox/cat control, and conflicting flora and fauna management objectives at bandicoot reserves.

Recovery Objectives and Actions

Long-term Objective

The long-term objective of this recovery plan is to minimise the probability of extinction of the Eastern Barred Bandicoot by establishing self-sustaining reintroduced populations which total a minimum of 2500 individuals.

Short-term 5 year Objective

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

- Establish self-sustaining reintroduced populations totalling 1000 individuals.
- Manage the sub-species to minimise any further loss of genetic diversity.
- Maintain and enhance community and institutional support

Program Implementation and Evaluation

The Recovery Plan will run for five years from the time of adoption and its implementation will be managed by the Department of Sustainability and Environment. The Eastern Barred Bandicoot Recovery Team will continue to oversee recovery actions for the species 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. This will allow for management at all reintroduction sites to be refined using an adaptive management approach. There will be an external review of the recovery program after four years of Recovery Plan implementation. This Recovery Plan will be reviewed and revised within five years of the date of its adoption.

Recovery Objectives, Actions and Performance Criteria

Specific Objective 1: Establish self-sustaining reintroduced populations			
Action	**Action**	**Action Details**	**Performance Criteria**
1.1	Establish minimum population targets for reintroduced populations. Responsibility: **Recovery Team**	Establish overall population target for recovery. Set population targets for each reintroduction site.	Population targets set for long-term and short-term recovery Population targets set for each reintroduction site.
1.2	Manage releases and translocations to meet site-specific population targets. Responsibility: **DSE/Zoos Victoria**	Establish minimum site occupancy or minimum capture rate targets which will determine when to stop releases. Conduct annual population monitoring at all reintroduction sites. Assess the need to supplement populations with captive bred animals to increase minimum population size. Evaluate the success of different release strategies. Based on release success data, develop criteria for reintroduction attempts that describe when new release sites should be considered 'unsuccessful' and abandoned.	Annually assess site population size against population targets.
1.3	Prevent further loss of genetic diversity. Responsibility: **DSE/Zoos Vic**	Develop and implement a genetic management plan that identifies the extent of animal movement (immigration) between populations	Genetic decline in Eastern Barred Bandicoots halted. Victorian Eastern Barred Bandicoots

		necessary to maintain levels of genetic variation. Annual collection of genetic samples from all reintroduced populations.	managed as single meta-population.
1.4	Monitor and exclude foxes and cats at each reintroduction site. **Responsibility: DSE/Parks Victoria/National Trust/East View Valley**	Maintain predator barrier fences to permanently exclude foxes. Conduct regular predator monitoring within fenced areas.	Annual reporting of predator activity and control programs. Annual reporting on the frequency and extent of fence maintenance undertaken.
1.5	Monitor and manage habitat at all reintroduction sites. **Responsibility: DSE/Parks Victoria/National Trust/ East View Valley**	Monitor habitat quality twice annually. Establish photopoints at all release sites. Set and maintain maximum population size of macropods at fenced sites.	Annual reporting and review of habitat condition at each site. Habitat condition for Eastern Barred Bandicoots maximised at all reintroduction sites.
1.6	Reintroduce Eastern Barred Bandicoots to Woodlands Historic Park. **Responsibility: DSE/CVA/Parks Victoria**	Repair the predator barrier fence and develop a monitoring and maintenance strategy. Monitor fox activity within the fenced area on an ongoing basis. Eliminate foxes within the fenced area. Develop and implement a kangaroo management strategy for the fenced area to prevent habitat degradation due to overgrazing. Consult with stakeholders. Prepare reintroduction plan. Obtain necessary permits.	Release of Eastern Barred Bandicoots to Woodlands Historic Park in 2011. Site specific population target reached by year 5.

1.7	Investigate (and if agreed implement) a release of Eastern Barred Bandicoots onto French Island. **Responsibility: DSE**	Investigate habitat suitability. Consult with stakeholders. Prepare introduction plan, including risk analysis.	Community support for trial. Trial undertaken and full release evaluated Landholder and licencing permits gained. Full release undertaken
1.8	Establish a large fox-free reintroduction site in south-west Victoria. **Responsibility: DSE**	Identify potential large reintroduction sites within the species range in western Victoria. Identify and liaise with potential partners. Use a multi-species management approach.	Secure funding for land acquisition, predator barrier fence construction and maintenance, and predator control.
Specific Objective 2: Maintain captive populations.			
2.1	Manage captive population to provide a secure insurance population and to provide required number of Eastern Barred Bandicoots for release. **Responsibility: Zoos Victoria/DSE**	Set captive population targets and review annually based on reintroduction requirements. Manage breeding to prevent further loss of genetic variation in the meta-population. Review captive breeding facilities annually and increase number of breeding pens if necessary. Identify research projects with the captive population that may improve the effectiveness of breeding and/or releases. Investigate the possibility of introducing Tasmanian founders into the population to increase levels of genetic variation.	Maintain the genetic diversity of the Eastern Barred Bandicoots. Individuals bred in captivity have necessary levels of fitness for release to the wild. Individuals for release available as required.

Specific Objective 3: Undertake community education and communication for the recovery program			
3.1	Maintain and enhance the level of community and agency support for the species' recovery. **Responsibility: DSE/Zoos Victoria, Parks Victoria.**	Hold three Recovery Team meetings per year. Produce and publish newsletters to inform the community and stakeholders about recovery progress. Maintain Eastern Barred Bandicoot website. Review and update interpretation and education materials.	Ongoing support for Eastern Barred Bandicoot recovery secured.

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Priority, Feasibility, Duration and Estimated Costs of Recovery Actions

Action	Description	Priority	Feasibility	Action Weighting	Cost Estimate					
		10 = high 1 = low	3 = high 1 = low	Priority + Feasibility >10= critical	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Total**
1	**Establish Self-sustaining reintroduced population**									
1.1	Establish minimum population targets for reintroduced populations.	10	3	**13**	$10,000	$0	$0	$0	$0	$10,0000
1.2	Manage releases and translocation to meet site-specific population targets	7	3	**10**	$20,000	$20,000	$20,000	$20,000	$20,000	$100,000
1.3	Prevent further loss of genetic variation	10	1	**11**	$10,000	$10,000	$10,000	$10,000	$10,000	$50,000
1.4	Monitor and exclude foxes and cats at each reintroduction site	10	3	**13**	$60,000	$60,000	$60,000	$60,000	$60,000	$300,000
1.5	Monitor and manage habitat at all reintroduction sites	7	2	**9**	$12,000	$12,000	$12,000	$12,000	$12,000	$60,000
1.6	Reintroduce Eastern Barred Bandicoots to Woodlands Historic Park	10	3	**13**	$150,000	$100,000	$100,000	$100,000	$100,000	$550,000
1.7	Investigate (and if agreed implement) a release of Eastern Barred Bandicoots onto French Island.	8	2	**10**	$30,000	$20,000	$20,000	$20,000	$20,000	$110,000

1.8	Investigate the feasibility of a release into a large fox-free site in south-west Victoria	8	1	**9**	$10,000	$10,000	$10,000	$10,000	$10,000	$50,000
2	**Captive population**									
2.1	Manage captive population to provide a secure insurance population and to provide required number of Eastern Barred Bandicoots for release	9	3	**12**	$20,000	$16,000	$16,000	$16,000	$16,000	$84,000
3	**Education, information**									
3.1	Maintain and enhance the level of community and agency support for the species' recovery.	10	2	**8**	$8,000	$8,000	$8,000	$8,000	$8,000	$40,000
				TOTAL	$330,000	$256,000	$256,000	$256,000	$256,000	$1,354,000

Appendix 1

Nationally threatened flora and fauna listed under the EPBC Act that occur in western basalt plains grasslands and may benefit from actions arising from this Recovery Plan.

Species	Common Name	Status (EPBC Act)
Reptiles		
Delma impar	Striped Legless Lizard	Vulnerable
Eulamprus tympanum subsp.*marnieae*	Corangamite Water Skink	Endangered
Tympanocryptis lineata pinguicolla	Grassland Earless Dragon	Endangered
Insects		
Synemon plana	Golden Sun Moth	Critically Endangered
Plants		
Agrostis adamsonii	Adamson's Blown-grass	Endangered
Cullen parvum	Small Scurf-pea	Endangered
Diuris basaltica	Basalt Golden Moths	Endangered
Diuris fragrantissima	Sunshine Diuris	Endangered
Dodonaea procumbens	Trailing Hop-bush	Vulnerable
Glycine latrobeana	Clover Glycine	Vulnerable
Lepidium aschersonii	Spiny Pepper-cress	Vulnerable
Lepidium hyssopifolium	Basalt Pepper-cress	Endangered
Leucochrysum albicans var. *tricolor*	Hoary Sunray	Endangered
Petalochilus ornatus	Ornate Pink Fingers	Vulnerable
Pimelea spinescens subsp. *spinescens*	Plains Rice-flower	Critically Endangered
Prasophyllum diversiflorum	Gorae Leek-orchid	Endangered
Prasophyllum frenchii	Maroon Leek-orchid	Endangered
Prasophyllum suaveolens	Fragrant Leek-orchid	Endangered
Pterostylis basaltica	Basalt Greenhood	Endangered
Rutidosis leptorhynchoides	Button Wrinklewort	Endangered
Senecio macrocarpus	Large-fruit Groundsel	Vulnerable
Senecio psilocarpus	Swamp Fireweed	Vulnerable
Xerochrysum palustre	Swamp Everlasting	Vulnerable