

JANUARY 2014

# SUB-REGIONAL SPECIES STRATEGY FOR THE SOUTHERN BROWN BANDICOOT





Published by the Victorian Government Department of Environment and Primary Industries  
Melbourne, January 2014

© The State of Victoria Department of Environment and Primary Industries 2013

This publication is copyright. No part may be reproduced by any process except  
in accordance with the provisions of the *Copyright Act 1968*.

Authorised by the Victorian Government, 8 Nicholson Street,  
East Melbourne.

ISBN 978-1-74287-814-0 (online)

For more information contact the DEPI Customer Service Centre 136 186

#### **Disclaimer**

This publication may be of assistance to you but the State of Victoria and its  
employees do not guarantee that the publication is without flaw of any kind or is  
wholly appropriate for your particular purposes and therefore disclaims all liability  
for any error, loss or other consequence which may arise from you relying on any  
information in this publication.

#### **Accessibility**

If you would like to receive this publication in an accessible format, such as large print  
or audio, please telephone 136 186, or email [customer.service@dse.vic.gov.au](mailto:customer.service@dse.vic.gov.au)

Deaf, hearing impaired or speech impaired? Call us via the National Relay Service  
on 133 677 or visit [www.relayservice.com.au](http://www.relayservice.com.au)

This document is also available in PDF format on the internet at [www.depi.vic.gov.au](http://www.depi.vic.gov.au)

Cover photo: © M. Legg 2010

# CONTENTS

<b>1.</b>	<b>Introduction</b>	<b>2</b>
1.1	Purpose of the Strategy	3
1.2	Scope of the Strategy	3
1.3	Area covered by the Strategy	3
1.4	Strategy development and consultation	4
<b>2.</b>	<b>Statutory context</b>	<b>6</b>
2.1	Commonwealth legislation	6
2.2	State legislation	7
2.3	Planning policy framework	7
<b>3.</b>	<b>Ecology of Southern Brown Bandicoot</b>	<b>12</b>
3.1	Distribution	12
3.2	Decline	13
3.3	South central region	13
<b>4.</b>	<b>Goals and key directions</b>	<b>15</b>
4.1	Conservation outcomes	15
4.2	Objectives	15
4.3	Strategic approach	15
<b>5.</b>	<b>Conservation measures</b>	<b>21</b>
5.1	Southern Brown Bandicoot management area	21
5.2	Broad scale integrated predator control	24
5.3	Habitat security and management: private land	26
5.4	Habitat security and management: public land	27
5.5	Royal Botanic Gardens Cranbourne	28
5.6	Koo Wee Rup Swamp project	29
5.7	Managing other suitable habitat	31
5.8	Research and adaptive management	31
5.9	Other strategic measures	32
5.10	Monitoring and reporting	32
<b>6.</b>	<b>Implementation and review</b>	<b>33</b>
6.1	Implementation	32
6.2	Reporting and review	34
<b>7.</b>	<b>References</b>	<b>36</b>

# 1. INTRODUCTION

This Sub-regional Species Strategy (strategy) for the Southern Brown Bandicoot has been prepared in response to obligations arising from the strategic assessment conducted under Part 10 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).<sup>1</sup>

The Melbourne Strategic Assessment evaluated the impacts of the Victorian Government's Program 'Delivering Melbourne's newest sustainable communities' (Program) on matters of national environmental significance listed under the EPBC Act.

The Program provides for urban development in four growth corridors within Melbourne's expanded 2010 Urban Growth Boundary and in 28 existing precincts within the 2005 Urban Growth Boundary. It also provides for the development of the Regional Rail Link (west of Werribee to Deer Park) and the Outer Metropolitan Ring Transport Corridor/E6 Road Reservation.

The Melbourne Strategic Assessment required the Victorian Government to make commitments to the Commonwealth Government in relation to conservation outcomes and measures to protect matters of national environmental significance. These commitments are outlined in 'Delivering Melbourne's newest sustainable communities: program report' (program report) (Victorian Government 2009), and include the preparation of this strategy.

The requirement to prepare this strategy arises from the program report. A commitment was made in this report that:

*Sub-Regional Species Strategies will be prepared for some specific matters of national environmental significance such as the Growling Grass Frog, Southern Brown Bandicoot, and Golden Sun Moth. These strategies will inform the preparation of the Biodiversity Conservation Strategies by identifying important populations, areas to be retained (where known) as required by prescriptions and habitat links. They will influence negotiations and the design of precincts that will occur during the preparation of precinct structure plans, as required by the relevant prescriptions. Each Sub-Regional Strategy must be approved by the Commonwealth Government prior to the finalisation of the Biodiversity Conservation Strategy.*<sup>2</sup>

This strategy has been informed by a commissioned technical report and associated recommendations for Southern Brown Bandicoot conservation (Biosis 2013a) and by detailed technical reports prepared by Practical Ecology (2011) and Ecology Australia (2013). The implementation of this strategy will be drawn from these three technical reports.

This strategy requires approval from the Commonwealth Government.

---

1 The results of the Strategic Assessment are set out in the 'Delivering Melbourne's Newest Sustainable Communities Strategic Impact Assessment Report' (DSE 2009).

---

2 Victorian Government 2009

## 1.1 Purpose of the Strategy

This strategy is a key mechanism to deliver the conservation outcomes for Southern Brown Bandicoot identified in the program report. These are:

- > Functioning sustainable populations within and adjacent to the growth areas, with connectivity between populations
- > Protection and enhancement of all populations, including the population at the Royal Botanic Gardens, Cranbourne.

The purpose of this strategy is to:

- > Identify important populations of Southern Brown Bandicoot and areas to be managed for Southern Brown Bandicoot conservation within and adjacent to Melbourne
- > Provide an implementation approach to deliver the conservation outcomes for Southern Brown Bandicoot identified in the program report over the medium and long-term.

## 1.2 Scope of the Strategy

This strategy sets out all the requirements for Southern Brown Bandicoot to satisfy the outcomes for the species identified in the program report and the specific requirements of the approved prescription for Southern Brown Bandicoot.

The strategy identifies all the requirements for urban development relating to the Southern Brown Bandicoot. No land is required to be retained for the Southern Brown Bandicoot within the 2010 Urban Growth Boundary, with the exception of the Royal Botanic Gardens Cranbourne (within the 2005 Urban Growth Boundary). However development will trigger a requirement to pay a compensatory habitat fee to fund the management of priority areas for Southern Brown Bandicoot management. These areas are primarily located outside Melbourne, but also include the Royal Botanic Gardens Cranbourne and hinterland (within Melbourne) (Figure 1).

This strategy establishes a Southern Brown Bandicoot Management Area outside Melbourne. It describes the rationale for this as a response to potential impacts as a result of urban development. This area includes public land and private land where landowners will be invited to participate in funded activities (e.g. fox control). The strategy also provides a framework for expenditure of compensatory habitat fees and implementation of conservation actions within the proposed management area. A component of compensatory habitat fees will be used to fund in perpetuity actions, to ensure that conservation outcomes for the Southern Brown Bandicoot in this area will be enduring.

This approach differs in some respects from that of the draft strategy released for public comment in 2011. In particular, designated habitat corridors linking the Royal Botanic Gardens Cranbourne to areas of habitat outside the urban growth boundary proposed in the draft strategy are now understood to be less cost-effective than alternative conservation measures designed to achieve the required outcomes for the species. Analysis of available conservation measures, including those proposed in the draft strategy is provided later in this strategy (see section 4.3).

## 1.3 Area covered by the Strategy

The Program, as defined in the program report, means the Urban Growth Boundary Review for Melbourne for the development of land, including associated transport infrastructure, within the following areas:

- > Investigation areas for the expansion of the 2005 Urban Growth Boundary
- > Areas inside the 2005 Urban Growth Boundary for which a planning scheme amendment to introduce a Precinct Structure Plan had not commenced as at 26 May 2009 (the existing 28 precincts)
- > Areas in the Outer Metropolitan Ring Transport Corridor/E6 Road Reservation and the Regional Rail Link corridor between west of Werribee and Deer Park (Section 2).

Melbourne's south-eastern growth corridor is the only growth corridor that contains habitat for Southern Brown Bandicoot. Accordingly, this strategy applies to:

- > The south-eastern growth corridor (Casey and Cardinia) within the expanded 2010 Urban Growth Boundary given effect by Planning Scheme Amendment VC68
- > Those existing 28 precincts within the 2005 Urban Growth Boundary that are located south-east of Melbourne, and for which a planning scheme amendment to introduce a Precinct Structure Plan is approved **after** 1 March 2012.

Obligations from this strategy do not apply to land outside the expanded 2010 Urban Growth Boundary as defined in the program report other than to guide where compensatory habitat fees may be spent. The Southern Brown Bandicoot Management Area does not convey any management obligations on landowners and participation in conservation programs will be voluntary.

This strategy was prepared using a larger study area that encompasses the south-central Victorian population of Southern Brown Bandicoot as broadly defined by Coates *et al.* (2008) and extending from Port Phillip Bay to Cape Liptrap, as shown in Figure 1. This larger area encompasses all the areas that appear likely to have constituted a single, south-central Victorian gene-pool at the time of European settlement and therefore represents a meaningful conservation planning area for the Southern Brown Bandicoot. This recognises and provides scope for a metapopulation approach to achieving the stated outcomes as described in Practical Ecology (2011).

Melbourne's south-eastern growth corridor covers a small portion of the range of the south-central population of the Southern Brown Bandicoot and the proposed Southern Brown Bandicoot management areas cover a slightly larger proportion of the south-central population (Figure 1).

## 1.4 Strategy development and consultation

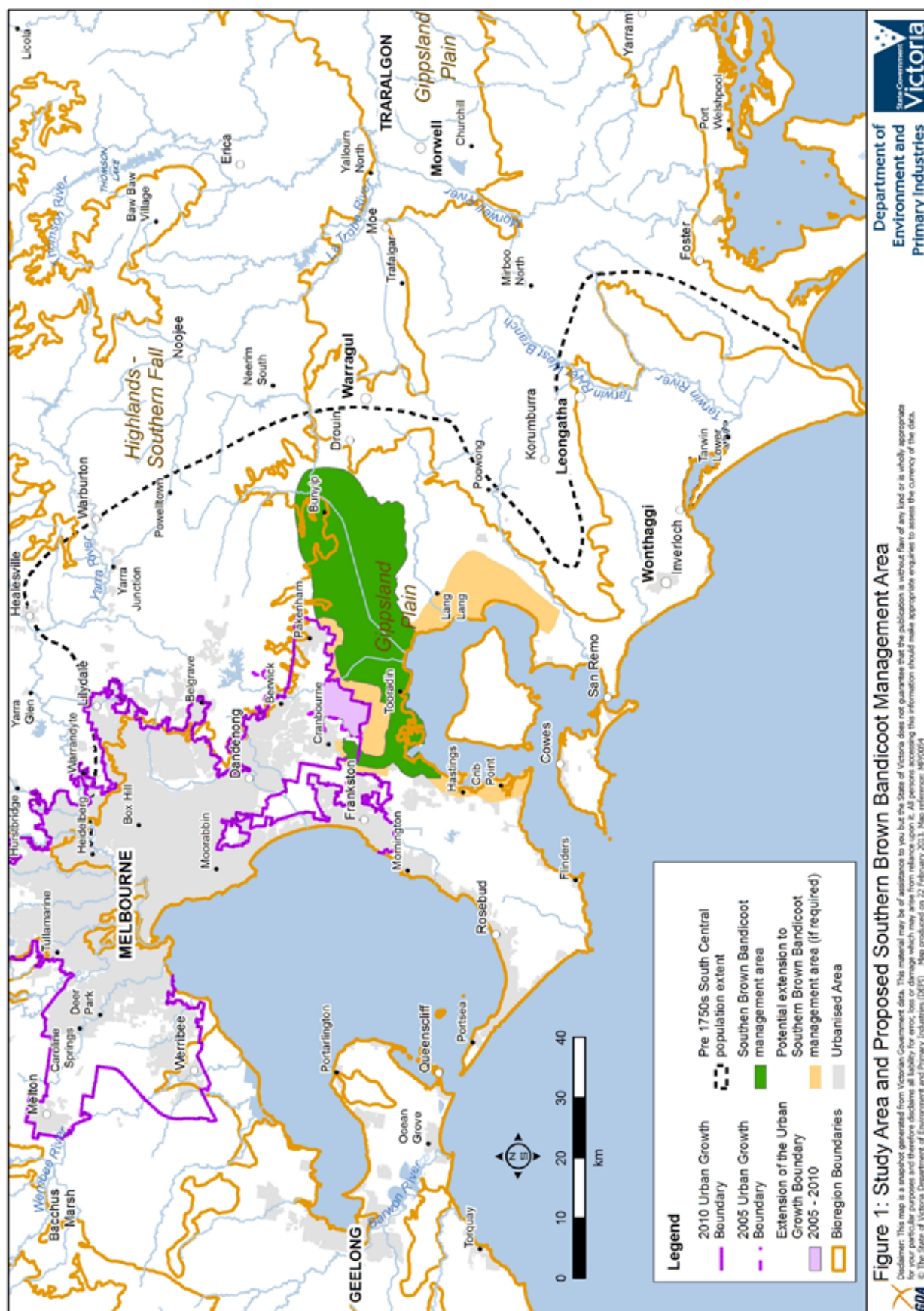
Department of Environment and Primary Industries (DEPI) (formerly the Department of Sustainability and Environment, DSE) is the lead agency for the preparation of this strategy.

The strategy is based on detailed advice and information from leading ecological consultants and scientists from the DEPI's Arthur Rylah Institute (Biosis 2013a, Ecology Australia 2013, Practical Ecology 2011). New surveys for the Southern Brown Bandicoot were undertaken to inform this strategy (Biosis 2013b). Several technical workshops were held throughout the strategy development process, and these included leading ecologists and mammal experts from universities, private consultancy and public agencies.

An agency working group was involved in the planning of this strategy, and its connection to the Growth Corridor Planning process. This included the Growth Areas Authority, the Department of Transport, Planning and Local Infrastructure (DTPLI) and the Department of Treasury and Finance.

A public consultation process was undertaken in November and December 2011 and submissions were sought on the draft strategy for Southern Brown Bandicoot and related draft conservation strategies and draft Growth Corridor Plans for Melbourne. The strategy was revised and updated as a result of submissions received during this process.





## 2. STATUTORY CONTEXT

The Southern Brown Bandicoot occurring in Victoria belongs to the south-eastern mainland sub-species (*Isoodon obesulus obesulus*). The south-eastern mainland population of Southern Brown Bandicoot is now considered in danger of extinction throughout south-eastern mainland Australia and has been subsequently listed as "Endangered" under the EPBC Act. The sub-species is also listed as "Threatened" under the Victorian *Flora and Fauna Guarantee Act 1988*.



Photo: © M. Legg 2010

### 2.1 Commonwealth legislation

The EPBC Act is the Commonwealth Government's principal environmental legislation and provides for the protection of matters of national environmental significance. Under section 146 of the EPBC Act, the Commonwealth Minister may agree to undertake a strategic assessment of the impacts of actions delivered under a policy, plan or program on these matters.

The 'Delivering Melbourne's Newest Sustainable Communities Strategic Impact Assessment Report' (DSE 2009) evaluated the impacts of the Victorian Government's Urban Growth Boundary Review for Melbourne Program on species and ecological communities listed under the EPBC Act, as well as on Ramsar-listed wetlands.

The Commonwealth Minister for the Environment, Heritage and the Arts endorsed the Program, as set out in the program report, in February 2010.

The endorsement of the Program under Part 10 of the EPBC Act was a necessary step prior to any approval by the Commonwealth Minister of classes of actions forming part of the Program in accordance with section 146B of the EPBC Act. No actions affecting matters of national environmental significance (e.g. removal of listed grassland vegetation) can be undertaken until an approval is granted by the Commonwealth Minister. Any approved action must occur in accordance with the endorsed Program and conditions set by the Commonwealth Minister.

The Commonwealth Minister has approved three classes of actions under the endorsed Program: Regional Rail Link corridor between west of Werribee and Deer Park (section 2) and development within the existing 28 precincts within the 2005 Urban Growth Boundary, in accordance with approved prescriptions; and development within the western, north-western and northern growth corridors within the 2010 Urban Growth Boundary.

Under the normal Part 9 approval process of the EPBC Act, the Commonwealth Government would typically expect known breeding habitat for the Southern Brown Bandicoot and dispersal corridors between such habitat to be avoided and protected from development, and may also seek to protect dispersal corridors that connect potential habitat if this forms part of a link to breeding habitat. The Commonwealth Government would not approve developments with unacceptable impacts and no compensation is payable for loss of development potential in these cases.

Removal of such habitat, which is consistent with the definition of an important population as defined by the Commonwealth in most cases would be considered a significant impact under the EPBC Act and would likely have some type of restriction placed by the Commonwealth Government on the amount that could be cleared. Compensatory habitat would be required for any such areas permitted to be cleared.



### 2.1.1 Program report

The program report is the primary statutory document associated with the Melbourne Strategic Assessment. It contains binding commitments on the part of the State Government to the Commonwealth Government.

The commitments in the program report include a requirement to establish planning mechanisms for implementing the various aspects of the program. This includes preparing a Biodiversity Conservation Strategy for the growth corridors and sub-regional species strategies to inform the preparation of Growth Corridor Plans and precinct structure plans.

The program report also identifies the conservation outcomes to be achieved for each matter of national environmental significance and the mechanisms for how these outcomes will be delivered. This strategy plays a key role in delivering the outcomes for the Southern Brown Bandicoot.

The program report outlines the steps for implementing the Program, including the logic and relationship between the key statutory documents. This strategy is a requirement of 'Stage 2: Process Implementation' (see Diagram 1).

## 2.2 State legislation

The *Planning and Environment Act 1987* (P&E Act) is the primary legislation for regulating the program in Victoria. The P&E Act provides for the preparation of a comprehensive set of provisions and policies for planning schemes, which regulate the use and development of land in Victoria.

The key state legislation that will apply at each stage of implementing the program is identified in section 4 of the program report. Other legislation may be triggered, depending on the nature of land use activity occurring (e.g. extractive industry and utilities). The program report also details the relevant planning policy mechanisms triggered by the legislation.

## 2.3 Planning policy framework

### 2.3.1 Growth Corridor Plans

Growth Corridor Plans (GAA 2012) (formerly referred to as Growth Area Framework Plans) were prepared by the GAA in conjunction with DTPLI, DEPI and with the involvement of other State Government departments and agencies and the growth corridor councils. These plans guide the creation of new communities within the growth corridors in accordance with the State Planning Policy Framework.

The plans set out the regional framework for the preparation of precinct structure plans within the growth corridors and show broad land use patterns, proposed transport networks, regional open space, important waterways and areas of environmental sensitivity.

The Growth Corridor Plans have been informed by this strategy and the Biodiversity Conservation Strategy (DEPI 2013a). The plans require approval by the State Minister for Planning.

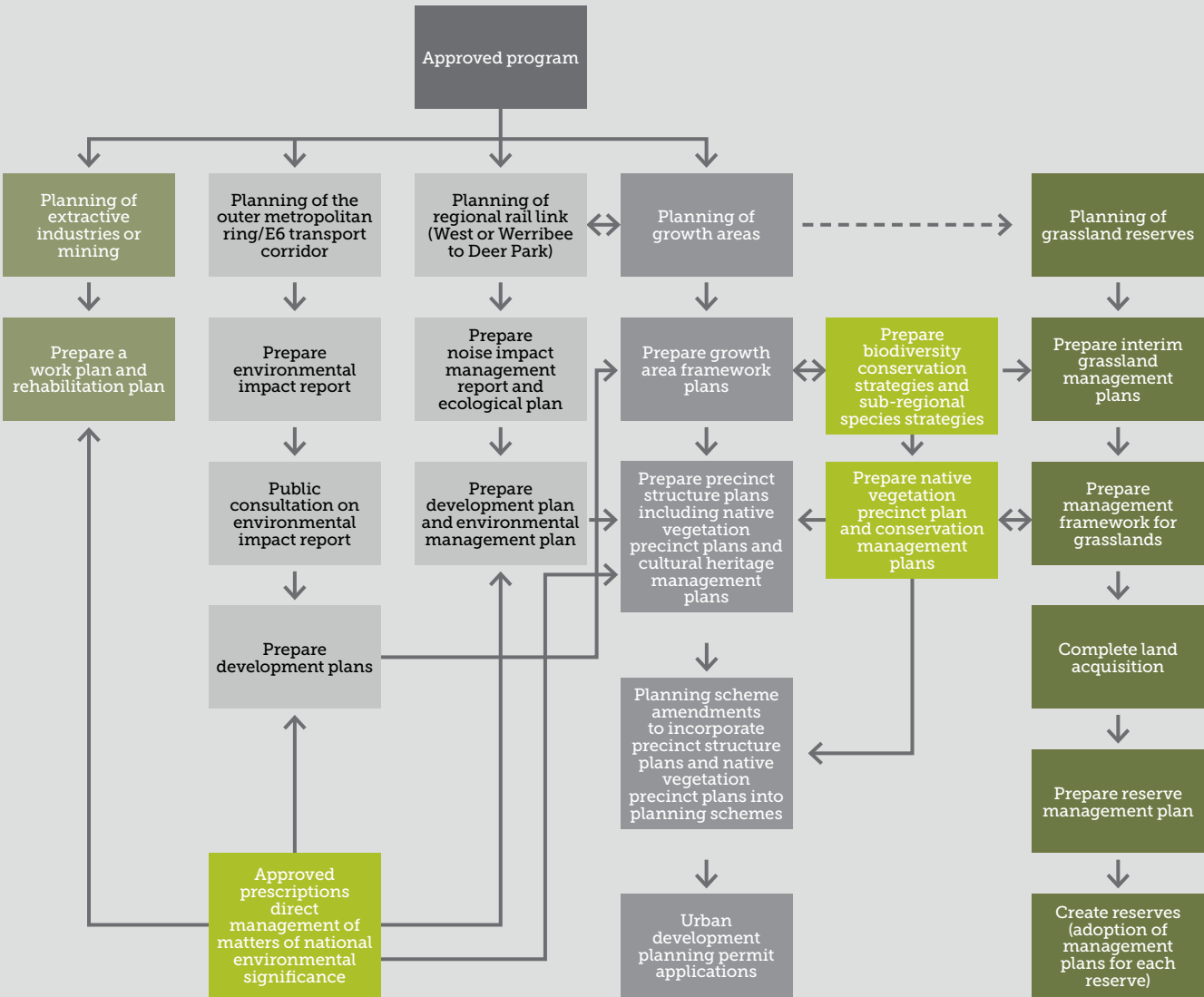
### 2.3.2 Biodiversity Conservation Strategy

The Biodiversity Conservation Strategy (DEPI 2013a) sets out all the requirements for matters of national environmental significance and state significance in the growth corridors to satisfy commitments made to the Commonwealth Government in the program report.

The purpose of the Biodiversity Conservation Strategy is:

- > Inform and guide the preparation of the Growth Corridor Plans
- > Outline how the conservation outcomes for matters of national environmental significance in the program report will be achieved spatially within the growth corridors and how impacts on these matters will be mitigated
- > Identify the land within the growth corridors that is required to be protected due to the sub-regional species strategies and the prescriptions for matters of national environmental significance
- > Identify how areas set aside for conservation will be managed
- > Outline how mitigation measures will be implemented.

Diagram 1: Process for Stage 2 of the Program – Implementation (Victorian Government 2009)



The Biodiversity Conservation Strategy identifies land within the growth corridors that cannot be cleared for urban development and will be protected and managed for conservation, and land that can be cleared. No additional land will be required to be protected during the precinct structure planning stage in the area covered by this strategy.

### 2.3.3 Precinct Structure Plans

Precinct structure plans set out the future structure of a suburb, detailing the location of housing, activity centres, community facilities, local transport networks, open space and areas of biodiversity value. The precinct structure planning process applies to land within the growth corridors and the existing 28 precincts within the 2005 Urban Growth Boundary.

The plans must be prepared in accordance with the Growth Corridor Plans and the Precinct Structure Planning Guidelines (GAA 2009). These guidelines provide guidance on the assessment, protection and management of biodiversity values within the precinct and identify outputs that must be produced, including a native vegetation precinct plan.

Precinct structure plans must be prepared and approved by the State Minister for Planning and incorporated into the relevant planning scheme before urban development can proceed (some exceptions apply). Once a plan has been incorporated into the relevant planning scheme, planning permits can be granted by the relevant authority (usually council) for urban development.

### 2.3.4 Planning permits

A planning permit is a legal document that gives permission for a use or development on a particular parcel of land under a planning scheme. The permit includes written conditions that must be satisfied in carrying out an approved use or development. The conservation outcomes in the program report may be given effect by the precinct structure plan informing the conditions of development and subdivision permits.

A planning permit is required for the removal of native vegetation unless an exemption applies. The Permitted Clearing of Native Vegetation – Biodiversity Assessment Guidelines (DEPI, September 2013) is a relevant decision guideline when assessing any proposal to remove native vegetation.

### 2.3.5 Native Vegetation Precinct Plans

Native vegetation precinct plans set out the requirements for the protection and removal of native vegetation within a precinct. In the case of the growth corridors, the plans are a tool used to protect Commonwealth listed ecological communities.

The plans must be prepared for each precinct within the growth corridors and the existing 28 precincts in accordance with Clause 52.16 of local planning schemes. The plans are prepared using native vegetation assessment and mapping to standards specified by DEPI.

Native vegetation precinct plans must be prepared based on the time-stamping maps and dataset (see DEPI 2013a), which will cover all native vegetation patches within the precinct, and will be supplemented by surveys of individual trees only.

The plans are incorporated into the relevant local planning scheme. The plans are prepared in accordance with DEPI's Biodiversity Precinct Structure Planning Kit,<sup>3</sup> and in accordance with the program report, must be consistent with the prescriptions.

3 The Biodiversity Precinct Structure Planning Kit (DSE 2010) provides direction on the type, detail and format of information to be provided in precinct structure plans in the form of mandatory templates. The kit specifies the state and Commonwealth governments' requirements to meet the standards and commitments in the program report. The kit is consistent with the Native Vegetation Management Framework. The kit will be reviewed periodically by DEPI and the GAA as planning processes are refined during the development of precinct structure plans and where necessary will be updated to reflect the new requirements and processes in the Biodiversity Conservation Strategy.



### 2.3.6 Conservation Management Plans

Conservation management plans outline how matters of national environmental significance and state significance will be protected and managed within a precinct and must be prepared where there are important populations or habitats of threatened species within the growth corridors that require particular management.

The plans are prepared as part of the precinct structure planning process. They will be prepared by DEPI in consultation with the landholder and relevant authorities as appropriate.

### 2.3.7 Prescriptions

The program report committed to preparing prescriptions for matters of national environmental significance. Impacts on matters of national environmental significance are not permitted until prescriptions for those matters have been approved by the Commonwealth Government.

The prescriptions establish requirements for the identification and protection of habitat for matters of national environmental significance, which influences the design of precincts during the preparation of precinct structure plans. The prescriptions also identify how impacts on these matters are to be mitigated, including through the provision of offsets (or compensatory habitat), translocation, and the implementation of a conservation management plan.

Prescriptions are required to be approved by the Commonwealth Environment Minister. The Minister approved prescriptions for most relevant matters of national environmental significance in 2010. These are:

- > Natural Temperate Grassland
- > Grassy Eucalypt Woodland
- > Golden Sun Moth
- > Striped Legless Lizard
- > Growling Grass Frog
- > Southern Brown Bandicoot
- > Matted Flax-lily
- > Spiny Rice-flower
- > Migratory species.

The program report allows the existing prescriptions to be revised in certain circumstances.

This strategy is consistent with and incorporates the requirements of the prescription for the Southern Brown Bandicoot. The implementation of this strategy will satisfy the requirements of the prescription and is designed to deliver the conservation outcomes for the species identified in the program report.

Once approved this strategy replaces the approved prescription for the Southern Brown Bandicoot within the growth corridors including the existing 28 precincts for which a planning scheme amendment to introduce a precinct structure plan is not approved prior to 1 March 2012.

### 2.3.8 Funding of the conservation measures

The conservation measures in this strategy will be funded using a cost recovery model. The model establishes the fees that will be collected from developers within specified areas of the South-Eastern growth corridor (section 6.1.1) and used to mitigate the impacts of urban development on Southern Brown Bandicoot habitat in the area covered by this strategy.

The cost recovery model has been developed in accordance with the State Government's Cost Recovery Guidelines and rules regarding competition policy.

DEPI has published a document describing the cost recovery model and detailing the fee structure and prices. This document (DEPI 2013b) also describes the financial integrity framework for the collection, expenditure and reporting of funds and the method for reviewing the fees over time. It may be updated periodically by the Victorian Government.

The fees will be governed through a specific trust that will include a requirement for regular reporting on income and expenditure and the results of independent audits.



## 3. ECOLOGY OF SOUTHERN BROWN BANDICOOT

The Southern Brown Bandicoot is known to occur within the Royal Botanic Gardens Cranbourne and elsewhere in the south-eastern growth corridor. It also occurs at several sites to the south and east of the expanded 2010 Urban Growth Boundary.

The technical reports prepared for this strategy summarise current knowledge in relation to the ecology and distribution of the Southern Brown Bandicoot. The text below is largely reproduced from Practical Ecology (2011).

### 3.1 Distribution

The Southern Brown Bandicoot (*subspecies Isoodon obesulus obesulus*) occurs in southern South Australia, southern Victoria and eastern New South Wales (NSW) with the Hawkesbury River a northern limit along the eastern coast (Paull 2003). Only two population strongholds occur in NSW, and in South Australia the species principally occurs within the Mount Lofty Ranges region and along the coastline of the state's south-east corner (Haby and Long 2005).

In Victoria, the species is predominantly coastal and exhibits a disjunct and patchy distribution across the state. Records are clustered around six general regions: far-east lowland Gippsland, western Gippsland Plain, Warnambool-Otway Plains, Glenelg Plain, and the Greater Grampians (Coates *et al.* 2008). As in other states, the species is generally associated with sites supporting heaths, heathy woodlands and forests or other vegetation communities providing a thick ground cover over sandy well-drained soils (Coates *et al.* 2008, Menkhorst and Seebeck 1990).

The area concerning this strategy occurs in what Coates *et al.* (2008) define for their study as 'south central Victoria', comprising the western section of the Gippsland Plains Bioregion and extending approximately south-eastwards from the Melbourne CBD to Cape Liptrap (Figure 1). Within this region, most records for the species occur between the northern sections of the Mornington Peninsula and Western Port Bay with a concentration between Frankston and Tooradin, which may reflect in part the occurrence of sandy soils and heath or heathy woodland vegetation (Coates *et al.* 2008) (Figure 2). More recent concentrations of records occur in Tooradin, Bunyip, Bayles, Quail Island, Cardinia, Royal Botanic Gardens Cranbourne, Clyde, Cranbourne, Koo Wee Rup, the Western Port coast-line, and between the lower reaches of Cardinia Creek and Deep Creek. Currently, the only dense population in the south central area occurs at the Royal Botanic Gardens Cranbourne (Coates *et al.* 2008), although the Quail Island population is likely to be fairly stable (Malcolm Legg pers. comm.).

Most records in the sub-region are associated with either patches of remnant vegetation, road reserves, rail lines, drainage lines or watercourses. Some records are associated with rough pasture, revegetation works (for bandicoot habitat), and market gardens. In general, records are widely dispersed across the eastern half of the sub-region where they are mostly associated with linear habitat, while in the west of the sub-region, records are restricted to much larger and isolated patches of contiguous habitat (Figure 2).



PHOTO: © M. Legg 2010

### 3.2 Decline

Extinctions of mammals in Australia represent approximately 50 percent of worldwide mammalian extinctions with 17 mammal species going extinct since European settlement. Bandicoots have been one of the most severely affected groups (Short and Smith 1994, Zenger *et al.* 2005, Johnson 2007). Eight out of 11 of the bandicoot species known to have occurred in Australia at the time of European settlement are now extinct or have experienced major range contractions and population declines (Strahan 1995, Maxwell *et al.* 1996). Bandicoots belong to a group of mammals known as 'Critical Weight Range' species which weigh between 35g–5500g and have experienced the most severe extinction rates or declines since European settlement. Declines in the distribution and abundance of Critical Weight Range species and extinction risk is primarily attributed to introduced predators and habitat loss, but also due to introduced herbivore competition, disease, pastoralism and altered fire regimes (Burbridge and McKenzie 1989, Short and Smith 1994, Kinnear *et al.* 2002, Bilney *et al.* 2010).

Since European settlement, the Southern Brown Bandicoot has experienced severe range contractions and population declines (Ashby *et al.* 1990, Zenger *et al.* 2005, Bilney *et al.* 2010). Maxwell *et al.* (1996) estimate that the south-eastern mainland subspecies has experienced a 50–90 per cent decline in its range.

Gould (1845) considered Southern Brown Bandicoot to be "one of the very commonest of Australian mammals" while recent research comparing pre-European settlement and modern diets of Sooty Owls, which include bandicoots, suggest that Southern Brown Bandicoot was one of the most common and abundant terrestrial mammals in south-eastern Victoria (Ashby *et al.* 1990, Coates *et al.* 2008, Bilney *et al.* 2010). As an indication of their abundance and potential extent of decline, Short and Smith (1994) report that of 21 million animals killed under bounty in NSW between 1883 and 1920, bandicoot pelts numbered over fifty-eight thousand.

Large-scale clearing or intense modification of open habitats soon after European settlement is likely to have significantly reduced the abundance and distribution of Southern Brown Bandicoot. Vegetation changes since European settlement have been shown to have had a 'profound impact' on the availability of habitat to the species (Paull 2003).

Overall, habitat modification and predation pressure by feral species, such as the fox *Vulpes vulpes* and cat *Felis catus* are likely the major factors in determining the local extinction or severe reduction in abundance and distributional range of many small mammal species, including Southern Brown Bandicoot (Short and Smith 1994, Bilney *et al.* 2010, Johnston 2007). More recent declines in the species range and abundance are also attributed to expanding urbanisation (Paull 2003), intensive agriculture (Menkhurst and Seebeck 1990) and further fragmentation and loss of habitat. Currently, the Southern Brown Bandicoot has a highly fragmented distribution (Paull 2003, Zenger *et al.* 2005).

### 3.3 South central region

While portions of the south-central population between south-eastern Melbourne and the northern Westernport area have been the subject of investigation in recent years, much of the former known range, including the foothills region between the upper Yarra Valley and Bunyip State Park have received little attention. Remote camera surveys designed to detect Southern Brown Bandicoots have been undertaken at a number of under surveyed locations during 2011 (B. Whitfield, DEPI, pers. comm.) and specifically to inform this strategy during 2012 (Biosis 2013b). These have found the species remains widespread within heathy woodland vegetation across much of Bunyip State Park. However the species was not detected in reserves at Coranderrk, Warramate Hills or Yellingbo in the Yarra Valley, nor at Lysterfield National Park; all places where there are historic records. Nor was it found at locations with apparently suitable habitat including Lang Lang Nature Conservation Reserve, the Holden Proving Ground and the HMAS Cerberus south of Hastings (Figure 2). It was detected in some areas of private property in the Garfield area and has recently been found also in Adams Creek Reserve near Lang Lang (Figure 2) (Biosis 2013b).



Historically, bandicoots may have occupied much of the south central region, perhaps reflecting high habitat suitability for the species prior to European settlement (Paull 2003). Early accounts note that Southern Brown Bandicoot was common around Melbourne and the Mornington Peninsula in the 1800s (Coates *et al.* 2008). The species occurred in the bayside suburbs of Sandringham, Black Rock and Beaumaris until at least the 1950s. Until the late 1960s the species was considered widespread across the east and south-eastern suburbs of Melbourne, occupying pockets of heathland, rough pasture and market gardens (Coates *et al.* 2008, Dixon 1966). In the latter half of last century, the species was noted as widespread on the Mornington Peninsula. By the late 1980s and early 1990s, it was considered still common at a site in Mordialloc, Springvale and two small reserves in Dingley and Keysborough. The species has not been observed within these areas in the last 15 years. Overall, the species has suffered significant range contraction within the south central area in the last 30 years, with several local extinctions occurring in the last 15 years and most occurring within the region's western half (Coates *et al.* 2008).

This decline is mostly attributed to habitat loss due to urbanisation and associated infrastructure, and also due to the impact of foxes on isolated populations (Menkhorst and Seebeck 1990, Coates and Wright 2003, Lechner 2006). Urbanisation and the impact of foxes on Southern Brown Bandicoot are inter-related due to urban areas supporting higher densities of these predators than rural habitats (Berghout 2000).

Within the sub-region Southern Brown Bandicoot is known to have substantially declined in the west of the sub-region with local extinctions occurring at Langwarrin Flora and Fauna Reserve, Pearcedale, Mornington Peninsula, Somerville-Tyabb and possibly the Pines Flora and Fauna Reserve and surrounds, or at least a substantial decline in the latter (Coates *et al.* 2008).

There is a stark contrast between the western and eastern halves of the sub-region. The western half of the sub-region is characterised by a high occurrence of suitable remnant habitat for Southern Brown Bandicoot but severe declines in occurrence, while the eastern half is characterised by relatively little remnant habitat but continued persistence of the species. The western half of the sub-region has experienced dramatic increases in urbanisation and human population, substantial habitat loss, and increasing diversity and intensity of land uses. In contrast, the eastern half of the sub-region has experienced relatively little change. The more urbanised western half likely constitutes a more hostile landscape matrix for Southern Brown Bandicoot by supporting potentially higher densities of foxes (Berghout 2000) and other predators (e.g. cats), higher traffic volume (road mortality), and more resistant landscape matrix for faunal movement (smaller lot sizes and urbanisation). The western sub-region is characterised by larger patches and more abundant suitable habitat but have significant discontinuities (e.g. fragmentation) and barriers (e.g. urbanisation and roads) at both a large and small scale. The eastern sub-region is characterised by a low total percentage cover of suitable habitat but the majority are linear, contiguous, and interconnected with other suitable patches with few significant barriers such as sealed, high traffic volume roads or urbanised landscapes.

A population viability analysis, which included populations around Cardinia, Casey, Frankston, and the northern Mornington Peninsula (incidentally covering all of the sub-region), strongly suggested that most populations in the sub-region would go extinct without active management (Lechner 2006). In addition, this population viability analysis did not take into account any further habitat loss or threats posed by further urbanisation such as that constituted by the expansion of the Urban Growth Boundary.

## 4. GOALS AND KEY DIRECTIONS

### 4.1 Conservation outcomes

The conservation outcomes for Southern Brown Bandicoot in the program report are to achieve:

- > Functioning sustainable populations within and adjacent to the growth areas, with connectivity between populations
- > Protection and enhancement of all populations, including the population at the Royal Botanic Gardens, Cranbourne.

### 4.2 Objectives

This strategy has identified the following objectives related to the conservation of Southern Brown Bandicoot from Biosis (2013a) and Practical Ecology (2011). Achieving these objectives is considered critical to the success of conserving the Southern Brown Bandicoot in the sub-region. Monitoring of this strategy against these objectives is discussed in Section 6.2.

Within the scope of the proposed conservation measures (sections 4.3 and 5), the primary objectives of this strategy are to achieve the following within the Southern Brown Bandicoot Management Area:

- > Prevention of any further local extinctions
- > Achievement of a net increase in distribution of occupied habitat
- > Achievement of a net increase of overall population size
- > Prevent loss of genetic diversity from the metapopulation.

The secondary objectives of this strategy are to achieve the following:

- > Greater public awareness of Southern Brown Bandicoot biology, conservation, and its importance in ecosystem function
- > Local community support for management actions
- > Increase in knowledge of species biology, distribution and management in the sub-region.

### 4.3 Strategic approach

#### 4.3.1 Principles and methodology

In developing the approach for this strategy, several potential management interventions were considered to achieve the required conservation outcomes for the species and the objectives of this strategy.

These interventions were derived from the work of Practical Ecology (2011) and Biosis (2013a) and were discussed and prioritised by leading ecological experts as part of the strategy development process (section 1.4). The resulting list of interventions was assessed against an estimate of their potential benefit to the species in the context of the south central population, the certainty that this benefit would be achieved, the practicality of delivery and cost. These are provided in Table 1 and discussed below.

Underpinning all of these interventions, a metapopulation approach as described by Practical Ecology (2011) is adopted in this strategy as a key underlying principle. A metapopulation is a group of spatially distant interacting subpopulations combined with patches of suitable unoccupied habitat. Individuals and genes are exchanged among populations and connected habitat patches. Immigration of individuals from connected populations and resultant re-colonisation of unoccupied habitat left open by population decline or extinction, stabilises populations and reduces the risk of overall decline or extinction (see Practical Ecology 2011). This theory emphasises the importance of connectivity among populations and particularly those within a fragmented landscape.





**Table 1:** Potential management interventions to deliver conservation outcomes for the Southern Brown Bandicoot (SBB) within the south central population, ranked in order of preference.

The logic of assigning “anticipated effectiveness” is similar to that used in Carwardine *et al.* (2011) (Anticipated effectiveness = Benefit X feasibility / Cost.) “Benefit” is conceived as the difference between the probability of SBB persistence when the action is implemented, and when no action is taken. Feasibility combines two concepts: 1) the certainty of the benefit being realized if the action is fully implemented, and 2) the practicality of implementation.

Management intervention	Benefit 4=very high 3=high 2=medium 1=low	Certainty of benefit	Practicality (delivery)	Feasibility 3=high 2=medium 1=low	Cost 4=high 3=medium 2=low 1=very low	Anticipated effectiveness (Benefit X Feasibility) / Cost
Broad-scale integrated predator control (e.g. “ark” program)	4	high	moderate	3	3	<b>4</b>
Additional management of SBB population on public land at Royal Botanic Gardens Cranbourne (urban)	1	high	easy	3	1	<b>3</b>
Private land habitat protection and simple management through incentives (rural)	2	moderate	easy	3	2	<b>3</b>
Land purchase, reservation and management of known SBB hotspots (rural)	3	high	moderate	3	3	<b>3</b>
Additional management on public land of known SBB hotspots (rural)	2	low	easy	1	1	<b>2</b>
Retain existing rural habitat corridors in KooWeeRup through assistance to statutory authorities (e.g. Melbourne Water, VicRoads, councils)	2	moderate	moderate	2	2	<b>2</b>
Reintroductions to unoccupied habitat	3	low	moderate	1	2	<b>1.5</b>
Plan and create new rural habitat corridors	3	low	moderate	1	3	<b>1</b>
Plan and create urban habitat corridors	3	low	difficult	1	4	<b>0.75</b>
Translocation to assist genetic health of extant populations	2	low	moderate	1	3	<b>0.66</b>
Improve management of existing urban habitat (public)	1	low	difficult	1	3	<b>0.33</b>
Protect and manage urban habitat (private)	1	low	moderate	1	3	<b>0.33</b>



Table 1 provide an indication of the relative cost-benefit of certain classes of interventions, in this case described as “anticipated effectiveness”, following the method used in Carwardine *et al.* (2011). “Benefit” in this case is the difference between the likelihood of persistence of the Southern Brown Bandicoot following the management intervention compared to no intervention occurring. All management interventions listed in Table 1 are assumed to have at least some benefit. The “anticipated effectiveness” of each intervention takes into account its benefit, its feasibility and its cost (Table 1).

For example, although reintroducing Southern Brown Bandicoots to areas of suitable but unoccupied habitat potentially has a high benefit to the species, as it would potentially create additional secure populations, the feasibility is currently assumed to be low. This is largely due to the inherent uncertainties of translocation, which means that the certainty of actually realising this potential benefit is considered low. In comparison, management of the Southern Brown Bandicoot population at the Royal Botanic Gardens Cranbourne is relatively low cost, has a high certainty in terms of realising the benefit (the management techniques are proven), but as it only affects one sub-population within a confined area has a relatively low benefit in relation to the overall south central population.

Integrated predator control is likely to be the most effective management intervention (Table 1). This is largely due to its very high potential benefit to species persistence across the management area combined with a high feasibility: the technique is proven in terms of delivering the benefits and, although challenging to implement, can be practically done. A successful predator control program will significantly reduce one of the biggest threats to persistence of Southern Brown Bandicoot within the south central population (Practical Ecology 2011, Ecology Australia 2013, Biosis 2013a).

Achieving protection and management of Southern Brown Bandicoot on private land through payments to landholders is likely to have a medium benefit to species persistence. Although incentive programs can be targeted to particular requirements or areas, the certainty of benefit for this species is currently only moderate due to the lack of information about where Southern Brown Bandicoot habitat exists on private land. This certainty is likely to increase in the future. However such programs are easy to deliver and relatively low cost compared to land purchase for example. As a result the anticipated effectiveness of this package of actions is considered to be high.

Voluntary land purchase and management provides a high level of benefit to species persistence. In addition the likelihood of achieving this benefit is high, as only land known to have high values for the species would typically be targeted for this approach. However relative to an incentive scheme, purchase of land generally has a higher financial cost. Despite this, targeted land purchase and management is a high priority management intervention due to its overall cost-effectiveness, as any money spent would be likely to deliver a high level of benefit for the species. It ranks similarly to private land habitat protection and management of the Royal Botanic Gardens Cranbourne population (Table 1).

The next ranked set of interventions both relate to management of public land. These two activities have a medium benefit to species persistence only. This is because, in comparison to a “do nothing” scenario, the actual gain in value of the site for the species as a result of the intervention is not likely to be dramatic, even though the site may be currently important. These two types of public land intervention are discussed separately below.

The first type of intervention relates to known areas of good quality habitat with a resident population of the species. These “hotspots” are public land reserved for a variety of purposes including biodiversity conservation (see section 5.4). Hence there is already a degree of protection for the species at these locations and relatively few management actions that could be used to increase the level of long-term protection for the species above current levels (e.g. enhanced reserve security or changed fire regimes as discussed in Section 5.4). As discussed in Section 5.4, any management actions must be over and above current management obligations at a particular site. Due to this limited scope for specific management actions, targeting Southern Brown Bandicoot hotspots on public land is considered to have a low overall feasibility, due to the uncertainty of realising the potential benefit. However the actual management actions required are likely to be very low cost and hence worthy of consideration depending on site specific circumstances. Where the available management interventions at a particular site are likely to deliver the potential benefit for the species, this approach is likely to be cost-effective.

In contrast the retention of linear habitat corridors within the Koo Wee Rup swamp has a higher feasibility, including a higher likelihood of realising the benefit, but potentially a higher cost. These areas of public land are not reserved for uses that include nature conservation and instead are managed for infrastructure purposes (e.g. drainage or roads) by the relevant public authorities. Hence there is more potential "gain" that could be achieved for the species over and above current management obligations, for example from retention of existing habitat, rather than its utilisation for other purposes. Retention of habitat within these areas is likely to achieve the potential benefit for the species given the known importance of this habitat to the overall maintenance of the Koo Wee Rup populations of Southern Brown Bandicoot. In some cases retention of habitat may result in higher delivery costs for the infrastructure, hence the cost of this intervention is considered to be higher than actions on public land "hotspots".

This assessment across a range of interventions across the south central population indicates that the creation of urban habitat corridors, while potentially of high benefit to the species within limited areas is a low priority due to other factors. This type of approach is essentially untested. The combination of elevated predation levels in the urban area, the emphasis on secure fencing to mitigate this threat and high land and infrastructure costs, indicates there is uncertainty that the desired outcomes would be achieved; there are also practical delivery difficulties and high cost (Table 1).

Other actions in the urban area, with the exception of those at the Royal Botanic Gardens Cranbourne, are similarly of low priority due to their relatively low anticipated effectiveness (Table 1). For example, managing existing habitat within the urban area, whether public or private, has the lowest benefit to the species across the south central population (Table 1). Such management approaches within the urban area also have a relatively high cost, including a much higher level of day to day management required to maintain the values of the site in the urban environment. Similarly there is considerable uncertainty in achieving the benefits and significant delivery challenges in many cases. Such interventions therefore rank very low in terms of cost-benefit (Table 1).

Another action that could be implemented under this strategy is research. This has been excluded from this analysis of anticipated effectiveness in Table 1 as it is an indirect action and does not in itself increase the persistence of the species.

Nonetheless it may be an important component to include as part of an adaptive management approach and simply to improve the cost-effectiveness of future interventions. For example the results of genetic research may indicate a higher or lower potential benefit (or feasibility) should be attributed to other interventions such as rural habitat corridors or translocation into extant populations, and therefore the relative priority of these interventions may change as a result of such research.

In addition, the interventions considered in Table 1 are not wholly independent, and the implementation of some may affect the potential benefits associated with another. For example if a broad-scale predator control program was already in place this would most likely increase the benefit to the species of a private land incentive program focussed on smaller scale management of habitat. This, together with the potential role of research, implies that the sequence and packaging of various implementation actions will be important. This is discussed further under Implementation (Section 6.1).

The management interventions listed in Table 1 are designed to achieve the conservation outcomes for Southern Brown Bandicoot in the program report. Table 2 indicates the relationship between each management intervention and each outcome, and whether they are likely to contribute to one outcome more than another. This relationship does not imply any particular importance for a class of management intervention but does help to ensure that the interventions chosen (section 4.3.2) are appropriate to addressing all the required outcomes.

### 4.3.2 Approach

The objectives of this strategy are set out in Section 4.2 above. It is intended that these objectives will be met over the long term, through a combination of:

- > Reduced threats from predation (particularly foxes)
- > Increased security of key locations
- > Improved management of existing habitat
- > Maintaining and increasing the extent of available linkages between sub-populations
- > Potential reintroductions to previously occupied habitat
- > Research to inform an adaptive management approach
- > Regular monitoring and reporting.



These actions include the higher priority management interventions on Table 1 (i.e. anticipated effectiveness more than one). A research component has also been included due to its importance in assisting future management decisions as discussed in Section 4.3.1.

As described in Section 4.3.1, potential management interventions in the urban area, with the exception of those at the Royal Botanic Gardens Cranbourne, are considered to be low priority based on a cost-benefit assessment (Table 1). Therefore the strategy will focus on conservation measures almost entirely outside the Urban Growth Boundary (UGB). The exception will be the Royal Botanic Gardens Cranbourne (RBGC) (and potentially some adjacent land) which contains an important population of the Southern Brown Bandicoot (SBB) and is located within the south-east growth corridor.

The primary approach will be to implement an integrated package of on-ground activities over a large specified management area extending across rural land to the south and east of Melbourne. A key action within this area will be broad scale and in perpetuity predator control. This will be supported by incentive programs on private land, targeted actions on public land, a continuation of Southern Brown Bandicoot conservation works at the Royal Botanic Gardens Cranbourne and a research program aimed at answering key questions about genetics and habitat usage by the species. The results of this research may result in changes to the implementation of conservation activities within the management area.

The initial focus of this strategy will be on establishing the detailed implementation arrangements, including preparation of a detailed implementation plan.

The conservation measures proposed to be used are described in more detail in Section 5.2. The Implementation arrangements for this strategy are discussed in Section 6.

**Table 2.** Relationship between management interventions and conservation outcomes for the Southern Brown Bandicoot.

Outcome A = Functioning sustainable populations within and adjacent to the growth areas, with connectivity between populations  
Outcome B = Protection and enhancement of all populations, including the population at the Royal Botanic Gardens, Cranbourne  
(Outcomes are taken directly from the program report.)

Management intervention	Relationship to Outcome A (functioning populations)	Relationship to Outcome B (protection of populations)
Integrated predator control	Primary	Primary
Manage Royal Botanic Gardens Cranbourne (urban)	Secondary (minor)	Primary
Private land incentives (rural)	Primary	Primary
Land purchase and management (rural)	Secondary	Primary
Additional management on public land (rural)	Secondary	Primary
Retain habitat corridors in KooWeeRup	Primary	Primary
Reintroductions to unoccupied habitat	Primary	Nil
New rural habitat corridors	Primary	Secondary
New urban habitat corridors	Primary	Nil
Translocation into extant populations	Secondary (minor)	Primary
Manage urban habitat (public)	Secondary (minor)	Primary
Protect and manage urban habitat (private)	Primary	Secondary (minor)

### 4.3.3 Future requirements for urban planning

As a consequence of the work completed for this strategy, there is no further survey required within the precincts covered by this strategy. No habitat is required to be retained within any of the precincts covered by this strategy. Developers must pay a compensatory habitat fee to DEPI prior to undertaking development works within specified areas of the south east growth corridor (refer section 6.1.1).

On land up to 1.5km distant from the Royal Botanic Gardens Cranbourne, and in particular within the urban portion of the Southern Brown Bandicoot Management area (Figure 1, 2), controls on the keeping of domestic cats will be required as discussed in section 5.2.

Payment of the compensatory habitat fee together with any required cat controls will be the only mandatory planning requirement in relation to the Southern Brown Bandicoot within the area covered by this strategy.



## 5. CONSERVATION MEASURES

### 5.1 Southern Brown Bandicoot management area

For the purposes of this strategy, a Southern Brown Bandicoot management area has been determined based on expert advice (Biosis 2013a,b). The determination of the management area considered:

- > The extent of the south central population
- > The distribution of known sub-populations
- > The conservation outcomes sought under the program report
- > The available management interventions
- > The overall effectiveness of this strategy.

This management area includes the Royal Botanic Gardens Cranbourne, and a much larger area outside the Melbourne Urban Growth Boundary (Figure 1 and 2). Activities funded under this strategy will occur within this management area. The primary management area may be extended into other "potential" areas as shown on Figure 2, based on expert advice. This is further discussed under Implementation (Section 6).

The management area is approximately 60,000 ha in size (Fig 1). However with the exception of some broad-based fox control works, funded management actions within this area will generally be limited to discrete areas of priority Southern Brown Bandicoot habitat and will not therefore apply to all of the area. The locations of all the priority habitat where management actions may occur will be determined during the implementation process.

The management area is a subset of the pre 1750 South Central Population (Biosis 2013a). It is almost exclusively located within the Gippsland Plain bioregion portion of the South Central Population, consistent with the South East growth corridor where impacts to Southern Brown Bandicoot habitat as a result of urbanisation will occur. A small area of the Highlands Southern Fall bioregion has been included near Bunyip to include some confirmed sub-populations that are likely to be part of the existing metapopulation within the Gippsland Plain component. As indicated on Figure 1, the management area does not extend further south than the northern shoreline of Westernport, and therefore excludes Wonthaggi and south Gippsland areas of the South Central Population, so as to maintain a connection with Melbourne and its hinterland, as set out in the program report.

The Southern Brown Bandicoot management area could potentially be extended to include parts of the eastern and western shoreline and hinterland if required, as shown on Figure 1. Although these areas include potential habitat and the confirmed population at Adams Creek Nature Conservation Reserve (Figure 2), it is likely that sub-populations in these areas are functionally separated from the balance of the management area due to relatively large, hostile breaks in available habitat. As identified in Section 3.3 above, the HMAS Cerberus south of Hastings was surveyed as part of the preparation of this strategy but these surveys failed to detect Southern Brown Bandicoot (Biosis 2013b).

The management area, and potential extension areas, therefore includes all the "recent confirmed subpopulation" locations from Biosis (2013a) on the Gippsland Plain component with the exception of the Wonthaggi Heathlands in South Gippsland. It also includes all of the area of the former Koo Wee Rup Swamp where scattered Southern Brown Bandicoot populations occur and extends into the neighbouring bioregion to include adjacent sub-populations (Figure 2). This area also encompasses the majority of the "potential habitat" locations documented in Biosis (2013a) and shown on Figure 2.



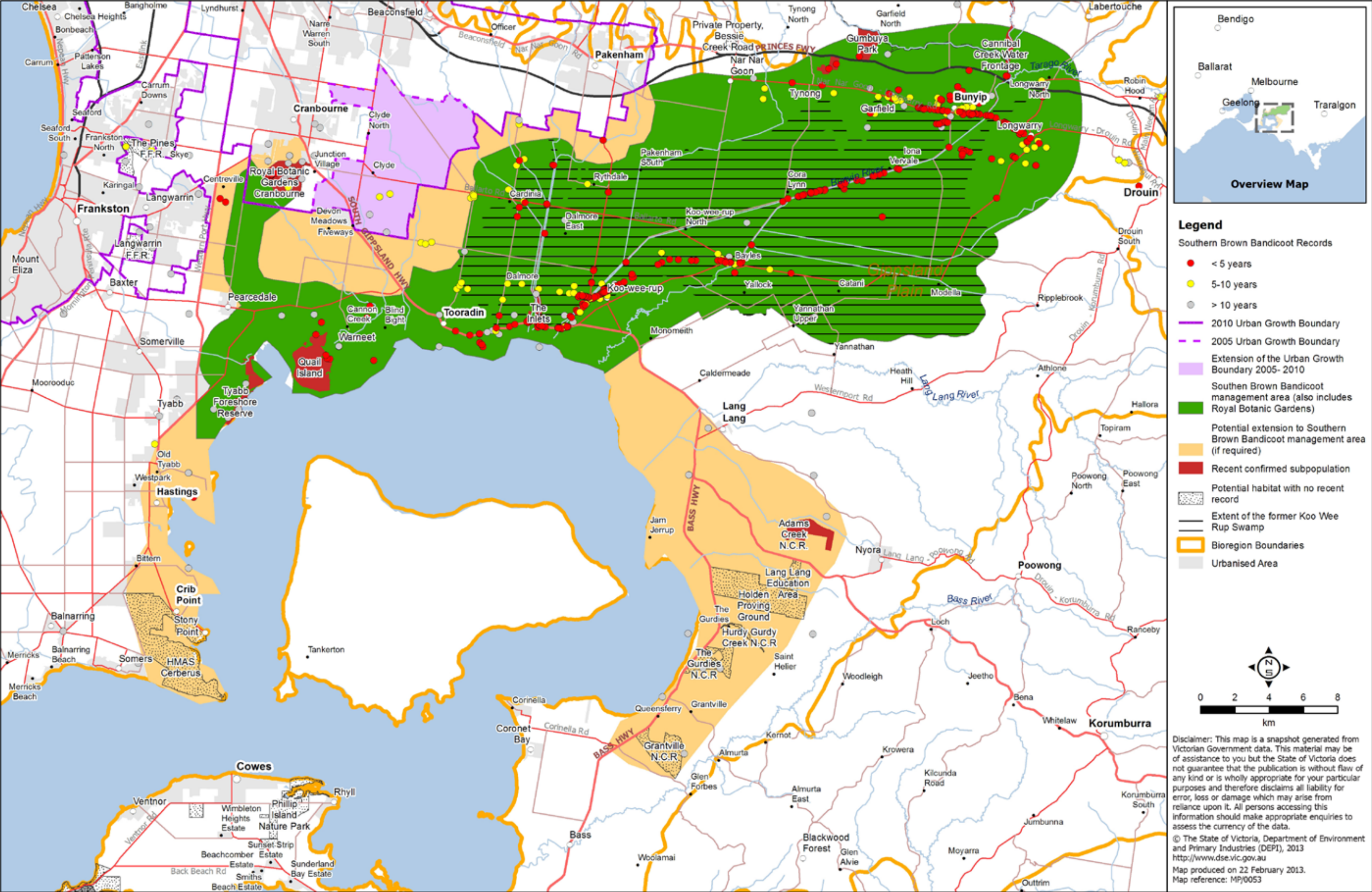


Figure 2: Southern Brown Bandicoot - Survey Records and Management Areas



Within this area, a package of integrated conservation measures will be implemented. Each of these is described below, largely summarised from Biosis (2013a).

Over the longer-term a controlled experimental approach will be required to ascertain what constitutes best management for particular locations. For example, the degree to which habitat connectivity will need to be specifically addressed and in which strategic locations will be ascertained as a result of the research program (section 5.8). This may influence the priority locations for on-ground works and will be particularly relevant to private land management (section 5.3 and potentially the integrated predator control component (section 5.2). In the interim, the Management Actions set out in Section 4 and the Habitat Management Guidelines set out in Section 5 of the technical report (Practical Ecology 2011) will be used to guide management of areas of habitat funded under this strategy.



## 5.2 Broad scale integrated predator control

The strategy will include an intensive, integrated and long-term predator control program within the south-central population region with its primary focus on the reduction in numbers of Red Foxes in key areas. This is assessed in this strategy to be the most cost-effective action (Table 1). It is also considered by Biosis (2013a) to be the measure that will be of greatest benefit to the Southern Brown Bandicoot. Elsewhere in Victoria, integrated predator control programs have been shown to substantially assist the recovery of Critical Weight Range native mammals, including the Southern Brown Bandicoot, by reducing the densities of foxes and feral cats (Biosis 2013a, Murray *et al.* 2006, Robley *et al.* 2011).

Specifics of predator control on behalf of Southern Brown Bandicoots, as they apply to urban, peri-urban and rural environments for the purposes of this strategy are outlined in Ecology Australia (2013). The approaches outlined in that document will form the basis of implementation of this component of this strategy.

The predator control component will be undertaken in perpetuity, within the constraints of the funding model (Section 6.1.1). It is intended to be applied across at least 50% of the management area (i.e. approximately 30,000 ha) to gain maximum effect, although the intensity and effectiveness in many areas will be reliant on landholder participation for access to lay baits (see section 5.3). An initial focus will be public reserves and surrounding areas in locations currently known to be inhabited by Southern Brown Bandicoots. In some locations, heightened control of cats and rabbits will likely be required in conjunction with a fox reduction regime. Details of the predator control program will be developed as part of implementation planning (section 6.1).

It is expected that reduced fox densities within the largely horticultural and agricultural landscapes of the management area will improve the capacity for Southern Brown Bandicoots to inhabit and/or move through those areas. Intensive fox reduction within these modified environments is considered by Biosis (2013a) to be the most effective action available to achieve landscape connectivity for the species in these areas.



PHOTO: © M. Legg 2010

The importance of maintaining and improving connectivity between Koo Wee Rup Swamp and the coast of Westernport to the Urban Growth Boundary in proximity to the Royal Botanic Gardens Cranbourne, along the coastal habitats of Westernport, and across the former Koo Wee Rup Swamp area, was emphasized by Practical Ecology (2011) and Biosis (2013a). These linkages will be facilitated by intensive fox reduction targeted within and around these areas.

Biosis (2013a) provide a "predator control zone" which includes all these areas and should form the basis for such an approach, subject to further implementation planning of the predator control program. These areas are all included with the Southern Brown Bandicoot management area described in section 5.1 and shown in Figure 2.

This strategy will also maintain and extend feral predator exclusion and control at the Royal Botanic Gardens Cranbourne, as set out in section 5.5. Feral predator exclusion fencing has been a key to maintenance of the important sub-population of Southern Brown Bandicoots at this location. Despite the intensive and on-going maintenance required, predator exclusion fencing may be applicable in some cases to other areas known to be inhabited by the Southern Brown Bandicoot within the management area, for example within portions of larger reserves to protect key habitats. The need for such fencing would be assessed during implementation planning (section 6.1).

Ownership of domestic cats should be prohibited in new urban developments within parts of the South East Growth Area of south eastern Melbourne, particularly within 1.5 kilometers of the Royal Botanic Gardens Cranbourne and where relevant in other parts of the Southern Brown Bandicoot Management Area (Figure 2) (Practical Ecology 2011, Biosis 2013a, Ecology Australia 2013). The feasibility of a domestic cat curfew, as has been enforced in a number of Victoria's municipalities, should be assessed and if possible introduced in existing urban areas within the same distance of the Gardens. These measures should be implemented under applicable local Government by-laws.

### 5.3 Habitat security and management: private land

There are several private properties within the management area where it is known that Southern Brown Bandicoot are present often in high quality native habitat. However for the majority of private land within the management area the importance for Southern Brown Bandicoot is unknown. Therefore further work will be done as part of the implementation of this strategy to investigate where Southern Brown Bandicoot populations may be using private land and where landowners may be willing to voluntarily assist with the management of the species and its habitat.

Incentive programs will be developed for this purpose as part of implementation of this strategy. These will include a BushTender type approach designed specifically for the management of Southern Brown Bandicoot in the target area.

Initially this is likely to include simple enhancement and protection for the species, for example:

- > Retention and maintenance of identified habitat
- > Permission to lay fox baits, or assistance with other pest animal control activities
- > Building and/or placement of small mammal refuges (boxes)
- > Fencing where necessary.

In native bushland areas, management of native vegetation, control of weeds and pests may also be included.

Incentive programs will be voluntary. They will be designed to pay landowners who agree to undertake the types of works above, most likely using a market based (e.g. tender) mechanism. Depending on the type of incentive, landowners would typically be required to sign a management agreement with DEPI or other public authority (e.g. local council).

Where the incentive payments are related to protecting or managing habitat, options may be provided regarding the length of time that an agreement would last. Preference would be given to permanent agreements that are secured on the land title (e.g. a management agreement with DEPI under Section 69 of the *Conservation Forests and Lands Act 1987*), particularly for higher priority habitats (larger, higher quality, strategic locations, confirmed population, etc.). These would be paid at a higher rate compared to simpler or short-term agreements.

Over time the tender (or other incentive program) would be designed to preference areas close to Southern Brown Bandicoot "hotspots" and to leverage off the predator control program (section 5.2). It would also be designed to prioritise habitat connectivity or other desirable attributes, depending on the results of the research program (section 5.8) and other emerging knowledge.

In some instances private land inhabited by the species and with good quality native habitat may be purchased and added to the Crown reserve system where landowners wish to sell their land. Depending on the cost of land purchase, this type of action is likely to have a high anticipated effectiveness as indicated in Table 1. Land purchase is more likely to occur in strategically important locations in the landscape.

Further work will be undertaken to determine suitable locations and delivery options for private land incentive programs in conjunction with landholders, municipalities and other key stakeholders.



## 5.4 Habitat security and management: public land

As shown on Figure 2 and in Table 3 the currently known key locations for retention and management of the Southern Brown Bandicoot are predominantly on public land.

There are seven areas of public land containing confirmed sub-populations of Southern Brown Bandicoot within the primary management area (Figure 2). These include one nature conservation reserve, as well as coastal, foreshore and streamside reserves. The Adams Creek Nature Conservation Reserve which also has a confirmed sub-population sits within the potential extension to the management area to the south-east (Figure 2). This list is not exhaustive and there are several other pieces of public land within the management area that contain suitable habitat and within which the species may be recorded in the future (Biosis 2013a).

These public land sites will initially act as the building blocks of this strategy from which other actions to increase habitat or promote habitat connectivity will be based. This strategy will put in place measures to provide for the continuation of suitable habitat for the species at these locations in the long term and the appropriate management and monitoring of these sub-populations.

Measures available to enhance the security of public land include a change of status to a conservation designation (e.g. Nature Conservation Reserve under the *Crown Land (Reserves) Act 1978*), or establishment of agreements between public authorities under the *Flora and Fauna Guarantee Act 1988*.

Public reserves will be important locations within which integrated predator control will be implemented (section 5.2).

**Table 3.** The currently known key locations for retention and management of the Southern Brown Bandicoot (SBB) within the South Central population extent (source: Biosis (2013a))

Site name	Tenure	Within primary SBB Management Area (Fig. 1, 2)	Within potential extension to SBB Management area (Fig. 1, 2)
Royal Botanic Gardens, Cranbourne	Public land	Yes	No
Bunyip State Park	Public land managed under the <i>National Parks Act 1975</i>	No	No
Quail Island	Public land	Yes	No
Western Port Coastal Reserve	Public land	Yes	No
North Westernport Nature Conservation Reserve	Public land	Yes	No
Tyabb Foreshore Reserve	Public land	Yes	No
The Inlets	Public land	Yes	No
Adams Creek Nature Reserve	Public land	No	Yes
Wonthaggi Heathlands	Public land	No	No
Bunyip Streamside Reserve, Bunyip North	Public land	Yes	No
Gumbuya Park	Private land	Yes	No



Appropriate fire management within areas occupied by Southern Brown Bandicoot is considered to be the primary tool for management of habitat in many cases, as discussed in Biosis (2013a) and Practical Ecology (2011). Within public reserves inhabited by Southern Brown Bandicoots, ecological burns for the conservation of the species will be prioritised over high frequency or more intensive fuel reduction measures in core habitat where practicable. The level to which this can be achieved at a particular reserve will be context dependent and will necessarily take into account other fire protection objectives for the public land and surrounding areas. Any such burns will be undertaken in accordance with Government regulations.

Other on-ground activities on public land may include revegetation, weed control or fencing parts of the site to exclude predators or to undertake management research trials.

Management plans for these areas of public land will be updated where relevant to reflect specific measures for the protection and management of the Southern Brown Bandicoot funded by this strategy.

While a range of actions on public land may be beneficial to the Southern Brown Bandicoot, any actions funded by this strategy must be clearly additional to existing obligations of the public land manager. This will be achieved through the implementation plan and reporting arrangements that will clearly identify the additionality provided by this strategy at these sites.

## **5.5 Royal Botanic Gardens Cranbourne**

A subpopulation of Southern Brown Bandicoot exists within the Royal Botanic Gardens Cranbourne and its immediate vicinity. This is the only subpopulation known to currently exist within the Urban Growth Boundary. This strategy will provide a long-term source of funding to assist with the conservation management of this population. The core habitat for the species at the Gardens is protected by a fox-exclusion fence and management currently includes capacity for removal of foxes if they penetrate the fence. Despite the fence young Southern Brown Bandicoots disperse through the fence and the species is regularly seen outside the fence and in the hinterland of the Gardens (T. Coates, Royal Botanic Gardens Cranbourne, pers. comm.)



To the extent feasible within constraints noted in background technical documents, this strategy should include implementation actions to reduce fox predation in the vicinity of the Royal Botanic Gardens Cranbourne (Biosis 2013a, Ecology Australia 2013). As discussed in Section 5.2 above and as advocated by Biosis (2013a), intensive fox control should be established with the aim of improving capacity for Southern Brown Bandicoots to move between the Urban Growth Boundary in proximity to the Royal Botanic Gardens and the nearest known subpopulations on the coast of Westernport and the former Koo Wee Rup Swamp. The need for controls over domestic cats in the vicinity of the Royal Botanic Gardens Cranbourne is also discussed in section 5.2.

Although land within the Urban Growth Boundary adjacent to the Royal Botanic Gardens Cranbourne is included within the Southern Brown Bandicoot Management area (Figure 2), it is recognized that not all this land will be available for on-ground works such as fox baiting due to its private ownership and sometimes small lot size. However areas of public land and larger lots remain and these may form the basis for complementary predator control in this area. This will be determined through the implementation process.

The Royal Botanic Gardens Cranbourne subpopulation has been studied over a number of years (T. Coates, Royal Botanic Gardens Cranbourne, pers. comm.) and it represents an important resource base for other priority research requirements that may be identified during the life of this strategy (section 5.8).

## 5.6 Koo Wee Rup Swamp project

As discussed in Practical Ecology (2011) and Biosis (2013a) a subpopulation of Southern Brown Bandicoot exists within the basin of the former Koo Wee Rup Swamp. The area is primarily within the Shire of Cardinia. It is largely used for horticulture and some agriculture.

Biosis (2013a) describe how throughout this area Southern Brown Bandicoots utilise linear and remnant strips and patches of indigenous and exotic vegetation. These remnant strips and patches are found within road reserves, the former South Gippsland rail line and drainage lines, including the major drains cut during the nineteenth and twentieth centuries to drain the swamp. Bandicoots also exist within the coastal zone of Westernport at the outfalls of the major drains. Some of the microhabitats used by the species here are novel and include old buildings and spaces beneath houses and it appears that they may forage out into horticultural and agricultural environments. Much is unknown about the ecology of the species in this environment and its actual distribution within the area has only been partially investigated. Academic study of some of these aspects is currently underway (S. Maclagan, Deakin University, pers. comm, Biosis 2013a).

It has been postulated that high productivity of the Swamp area may be beneficial for the bandicoots and Flack (2010) has suggested that the density of foxes may be lower here than it is within urban and peri-urban environments.

While suitable habitat for the species occupies only a very small portion of the Koo Wee Rup swamp area (Flack 2010), the habitat is scattered over the swamp which occupies a total area of approximately 30,000 ha (Yugovic 2011) (Figure 2). The subpopulation within the swamp area appears to be important and it is likely to be providing gene-flow across a large landscape block (Biosis 2013a). It is thus considered important to ensure the persistence of the species there.

A comprehensive management plan for the Koo Wee Rup population has been prepared for the former Koo Wee Rup Swamp area (Ecology Australia 2008). This plan was prepared for the Shire of Cardinia, City of Casey and Melbourne Water. It includes several objectives, some of which are similar to the objectives of this strategy. The plan emphasizes the need for feral predator control in this area and identifies several other priority actions to be implemented over the long term. These are described in some detail in Ecology Australia (2008).

It is understood that several of the actions have been or will be implemented as they relate specifically to the responsibilities of the three public authorities involved (two councils and Melbourne Water). Some of the research recommendations are also being implemented (S. Maclagan, Deakin University, pers. comm.). However it is also understood that several of the actions are aspirational and require further resourcing and coordination amongst several stakeholders to be implemented. These include actions such as integrated predator control across the swamp area, incentive programs for private landholders, creation of habitat links, land purchase and so on. Where these actions are unfunded and beyond current land manager obligations, it is appropriate for the strategy to fund and implement these conservation measures, where this fits with overall priorities to be determined during implementation planning (section 6.1).

A summary of the types of actions identified in the Koo Wee Rup Swamp management plan, and potentially funded by this strategy is provided below. These actions are discussed in detail in the plan itself (Ecology Australia 2008). The actions include several of the actions identified elsewhere in Section 5 of this strategy but importantly are related to the particular characteristics of the swamp area.

The former Koo Wee Rup Swamp area will be included in a program of intensive, coordinated and long-term feral predator control as described in section 5.1.1. It will be designed to be implemented across all land tenures and will focus on habitat known to be used by Southern Brown Bandicoots and surrounding areas. It may not be required to be as intensive as in some other parts of the Southern Brown Bandicoot management area if the anecdotal evidence regarding lower fox densities here is confirmed. The design of these programs on private land will require careful consideration given the largely horticultural nature of the area.

Further survey will be undertaken for the Southern Brown Bandicoot in particular parts of the Koo Wee Rup Swamp area to inform management priorities, building on current studies underway by Deakin University (S. Maclagan, Deakin University, pers. comm.).



Ownership or management responsibility of all public land known to be used by Southern Brown Bandicoots in Koo Wee Rup Swamp will be identified and, where relevant, a reservation status to better prioritise land for the conservation of Southern Brown Bandicoots will be investigated as described under Section 5.4. Authorities responsible for management of public land and waterways in the area, including Cardinia Shire, Melbourne Water and VicRoads, will be included in the implementation of this strategy, in particular the relevant actions identified in Ecology Australia (2008). It is important that these authorities manage land in a manner beneficial to conservation of the Southern Brown Bandicoot, given the importance of linear habitat remnants to connectivity and refuge throughout the swamp area. This may consider for example slashing, burning and weed control on roadsides and major drainage easements or grazing of livestock on Crown land and stream frontages. Planning controls may be relevant to further protect such habitats for Southern Brown Bandicoot within the relevant planning schemes.

A range of potential options are available to protect and enhance Southern Brown Bandicoot habitat on private land, consistent with section 5.3. Given the characteristics of the area, and the emerging information about usage of the area by the species, it is expected that some innovative and potentially low cost management options to protect and manage the species could be developed, and in ways that integrate with current land-use. This again recognizes the extensive horticultural and agricultural areas within which it is suspected the Southern Brown Bandicoot feeds, but also the importance of linear habitats within which the species shelters and moves. These novel management options should be built into the design of incentive schemes such as a tender type approach (section 5.3).

Further research, using a controlled experimental approach, is required to determine the best method of replacing weed species currently used by the species for shelter (e.g. regionally controlled blackberry and gorse) in a manner that does not have medium or long-term detrimental effects on the Southern Brown Bandicoot population. Again the habitat characteristics of the swamp area suggest low-cost management options may be able to achieve effective results in this part of the landscape.



## 5.7 Managing other suitable habitat

Areas of suitable habitat where Southern Brown Bandicoots have not been documented in recent years are shown on Figure 2 within the proposed management areas. These are discussed in more detail in Biosis (2013a). It appears likely that the species is now either locally extinct or in low densities at these locations most of which are within the public reserve system. Recent targeted surveys have failed to detect Southern Brown Bandicoots at a number of these locations (Biosis 2013b). At others a general lack of evidence for the species is the basis for a similar assessment. This list of sites is not exhaustive and it is expected that other areas of suitable apparently unoccupied habitat will be revealed during the various activities funded under this strategy.

Based on the results of targeted surveys, any of these sites where a subpopulation of Southern Brown Bandicoots is found should be managed as for all other sites inhabited by the species.

At locations where no population is detected, management actions will include efforts aimed at improving their capacity to support an increased or reintroduced Southern Brown Bandicoot subpopulation (e.g. fox baiting). Such actions will be applied at larger and more intact blocks of habitat; however the extent to which this is considered a priority over and above other actions will be determined on the basis of expert advice as part of implementation planning (section 6.1).

Priority should be given to improving the quality of such areas within the Southern Brown Bandicoot management area on the basis of the following criteria:

- > The site adds significantly to recolonisation of the former distributional range of the south-central Southern Brown Bandicoot metapopulation
- > The site offers increased security to the south-central metapopulation (e.g. by virtue of it being unlikely to be affected by fire or disease events that might affect existing subpopulations)
- > All management actions required to support an increased or reintroduced Southern Brown Bandicoot population to the site are clearly identified, fully costed and their feasibility is evaluated
- > Some complementary management actions aimed at improving the potential value of the site for Southern Brown Bandicoots have been undertaken successfully (e.g. fox control).

Potential reintroduction to unoccupied suitable habitat is likely to be a cost-effective action for some sites (Table 1). The extent to which this occurs will depend in part on genetic research (Section 5.8). If reintroduction of Southern Brown Bandicoots is considered necessary for any intended conservation outcome, all requirements of the *Procedure Statement for Translocation of Threatened Native Vertebrate Fauna in Victoria* (DSE 2013) (or as updated) must be met. Following any reintroduction, monitoring will be undertaken of sufficient intensity to determine the survival and on-going prospects of the animals and to permit rapid management response as required.

## 5.8 Research and adaptive management

At present there are a number of uncertainties about the biology of the Southern Brown Bandicoot and the specifics of some management measures for its conservation.

There are several locations where there are historical records, but no recent records of the species, that have not been thoroughly investigated recently. New technologies, especially the use of remote cameras, have recently improved survey and detection probability for the species and more comprehensive surveys should be undertaken at these locations. This will improve capacity for this strategy to more adequately address conservation of the species across the entire south-central metapopulation.

Some relevant studies currently underway are investigating topics such as genetic diversity of the south central population (M. Cairns, Zoos Victoria pers. comm.) and use of habitats within the Koo Wee Rup Swamp area (S. MacLagan, Deakin University pers. comm.). Implementation of this strategy will incorporate relevant findings from these studies into planning for the species as these become available. These or similar investigations will be supported and their scopes increased, as required, to encompass all aspects of relevance to conservation management of the south-central metapopulation.

The investigation of genetics should evaluate the level of genetic diversity within all subpopulations and across the metapopulation. This would provide a vital benchmark against which to assess genetic diversity in the future. Re-evaluation to measure change in genetic make-up of subpopulations and the entire metapopulation should be undertaken at predetermined intervals of no more than five years. On the basis of this genetic investigation, plans should be formulated to maintain genetic diversity at all sites. It is anticipated that, if demonstrably necessary, genetic diversity could be maintained, as required, by occasional translocations of small numbers of individuals between various subpopulations. Translocation for this purpose is not currently considered to be a highly cost-effective action (Table 1), however if the research indicates a higher potential benefit to the metapopulation by this approach this assessment will likely change.

As discussed in section 5.5, the Royal Botanic Gardens Cranbourne has a good level of baseline data and lends itself to further research to build on this body of work. An investigation of population demographics, including success of natural emigration and immigration by Southern Brown Bandicoots to and from the Royal Botanic Gardens Cranbourne subpopulation would be a useful means to obtain information of relevance to management of other sites and as a baseline against which to measure the success of predator control measures.

## 5.9 Other strategic measures

Planning controls may be a useful adjunct to the specific measures outlined above. For example a specific Environmental Significance Overlay over priority areas for the species (e.g. strategic habitat linkages) as recommended by Biosis (2013a) and Ecology Australia (2008) may be an appropriate tool to assist with the long-term security of these, and to reinforce on ground management programs such as broad scale fox control programs. Such an approach has been used elsewhere to maintain strategic biodiversity requirements in conjunction with other strategic planning (e.g. City of Frankston).

The need for appropriate planning controls will be investigated as part of the implementation planning process (Section 6.1).



## 5.10 Monitoring and reporting

Monitoring will be an integral part of the implementation of this strategy.

The program report requires monitoring of Southern Brown Bandicoot management approaches to assess their effectiveness in achieving the stated conservation outcomes.

The monitoring program will therefore be designed to:

- > Test the performance of this strategy against its objectives and outcomes for the Southern Brown Bandicoot (Section 4)
- > Assist with the choice of conservation measures, or the design of particular programs, to achieve these objectives.

The overall monitoring approach will be designed as part of the Monitoring and Reporting Framework currently under development as a requirement of the program report. The monitoring approach will incorporate adaptive management principles as described in the Biodiversity Conservation Strategy (DEPI 2013a). The results of monitoring, in conjunction with additional information gathered from research (Section 5.8), may result in changes to the conservation measures used to implement this strategy.



## 6. IMPLEMENTATION AND REVIEW

### 6.1 Implementation

Several government agencies will be involved in the implementation of this strategy, together with local councils and water authorities, private organisations, landowners, consultancies and land management bodies.

Implementation of this strategy within all areas outside the expanded 2010 Urban Growth Boundary will be voluntary. No obligations apply to private landholders within these areas as a result of this strategy.

The conservation measures outlined in this strategy may need to alter if new information becomes available or if management actions are considered inappropriate or inadequate to achieve the objectives of this strategy for Southern Brown Bandicoot. This will be addressed within the Monitoring and Reporting Framework (Section 6.2).

#### 6.1.1 Funding and governance

As indicated in Section 2.3.8, the conservation measures in this strategy will be funded using a cost recovery model. Fees will be collected from developers and used to mitigate the impacts of urban development on Southern Brown Bandicoot habitat in the area covered by this strategy.

One of the main elements of this strategy is ability to deliver some of the actions "in perpetuity". A dedicated fund will be established either within DEPI or with an external body. This fund will be the repository of fees collected from development within the south-east growth corridor of Melbourne. The fund will be established in a way that can earn interest on investment, to provide an "in perpetuity" funding component for some actions (e.g. fox control). The expected quantum of fees to be collected and therefore the total funding of this strategy is \$30 million.

An advisory committee for Southern Brown Bandicoot will be established to advise DEPI on implementation of this strategy including funding priorities. Membership will comprise technical experts; representatives of local government and state government authorities; community representatives; and relevant non-government organizations (e.g. Southern Brown Bandicoot regional recovery group). DEPI will be the lead agency for coordination of the Committee. Expenditure decisions will ultimately be the decision of DEPI.

Funds will only be used on priority recovery actions within the Southern Brown Bandicoot Management Area (Fig 1), including within the Royal Botanic Gardens Cranbourne (inside the Urban Growth Boundary) unless, on the advice of the advisory committee, DEPI determines that it is prudent to fund activities within parts of the potential expansion areas shown on Figure 2. The Southern Brown Bandicoot advisory committee will prepare an annual report of expenditure and actions under this strategy, and this will be published by DEPI.

Much of the undeveloped parts of the south east growth corridor, particularly where this land is still connected to habitat beyond the Urban Growth Boundary, provides for dispersal and foraging opportunities for the Southern Brown Bandicoot. Throughout this area it is not possible to document specific areas of habitat for the Southern Brown Bandicoot that may individually trigger "offsets". This is in large part due to the functional role of this land as dispersal areas, even if Southern Brown Bandicoot is not actually resident at these locations. These dispersal areas are believed to be important and will be removed as result of urban development within the south east growth corridor (DSE 2009, Practical Ecology 2011).

The cost of mitigating impacts on the Southern Brown Bandicoot will therefore be apportioned across all these relevant parts of the growth area, consisting of all the land brought into the Urban Growth Boundary in the south east in 2010 and also the large undeveloped precinct structure plan areas of Botanic Ridge, 'Minta Farm' C21 Business Park, Officer Employment, Pakenham Employment Stage 1 and Pakenham Employment Stage 2. This is because there is a direct connection between the impact of this urban growth and the loss of connectivity and functional habitat for the Southern Brown Bandicoot in these areas.

### 6.1.2 Implementation plan

An initial detailed implementation plan will be prepared by DEPI in conjunction with the advisory committee following consultation and design of conservation programs for the Southern Brown Bandicoot. Allocation of future priority actions will be undertaken by the Southern Brown Bandicoot advisory committee who will develop regular five-yearly implementation plans and set annual targets for management actions. These will be published by DEPI. A sample of some of the actions that may be considered within an Implementation Plan is outlined in Table 3 of Biosis (2013a).

### 6.1.3 Timeframes

Implementation commitments in this strategy are listed in Table 4.

The initial focus of this strategy will be on establishing the detailed implementation arrangements, including preparation of an initial detailed implementation plan, scoping and commissioning scientific research and undertaking high priority conservation measures for the Southern Brown Bandicoot at the Royal Botanic Gardens Cranbourne. This will occur over the short-term.

This will be followed by implementation of on-ground programs within the management area on private and public land in conjunction with a monitoring program. These programs will be scaled up over the short to medium term as compensatory habitat fees are paid as a requirement of urban development proceeding within the south-east growth corridor. This allows time for interest to accrue and the trust to build up to the requisite level to enable some in-perpetuity actions.

Over the long-term, and after urban development has completed within the south-east growth corridor an ongoing program of integrated predator control will continue using interest from the trust fund.

## 6.2 Reporting and review

Reports detailing the outcomes of progressive implementation and effectiveness of this strategy, will be submitted to the Commonwealth Government every two years, or as specified in the Monitoring and Reporting Framework. These reports will be made publically available on the DEPI website.

The performance of this strategy in terms of achieving the intended objectives and outcomes described in section 4 will be reviewed five years after the initial detailed implementation plan is published and adopted by DEPI and every 10 years following the first review. The reviews will be informed by the results of monitoring (Section 5.10). A report will be published following each review. If considered necessary, adjustments to this strategy will be identified during these reviews. Any adjustments would need to be to the satisfaction of the Commonwealth Government.



**Table 4.** Funded implementation commitments in the Sub-regional Species Strategy for Southern Brown Bandicoot

Commitment	Mechanism	Performance measure	Completion date / timeframe
<b>Long-term funding mechanism</b>	Interest bearing trust fund	Trust fund established Governance arrangements and rules published	2015 2015
<b>Southern Brown Bandicoot advisory committee</b>	Advisory committee	Membership and terms of reference published	2014
<b>Initial implementation plan</b>	Detailed initial implementation plan prepared by DEPI in conjunction with advisory committee	Initial plan published	2016
<b>Regular implementation plans</b>	Implementation plans updated by advisory committee	Implementation plans updated and published every 5 years Implementation plans include annual targets	2018–2040
<b>Maintain population at Royal Botanic Gardens Cranbourne</b>	On-ground works including predator-proof fence, fox baiting and monitoring	Fence maintained Southern Brown Bandicoot population stable	Ongoing
<b>Domestic cat controls</b>	Permit conditions, s173 agreements, local laws	New subdivisions within 1.5 km of RBGC required to be “cat-free”	2013–ongoing
<b>Integrated predator control program</b>	Coordinated multi-tenure program	Program manager appointed Program commenced (timing and scope subject to initial implementation plan) and scaled up to c. 25000 ha Approach generally consistent with Ecology Australia (2013) Data collected to measure effectiveness	2017 2018–ongoing
<b>Private land management</b>	Incentive programs to deliver on-ground works (e.g. fox-baiting, fencing, habitat restoration, monitoring, enhanced security)	First incentive program launched	2018
<b>Public land management (including KooWeeRup area)</b>	Conservation activities on public land (e.g. fencing, habitat restoration/maintenance, enhanced security, monitoring) where this is beyond current management.	Scope of work included within initial implementation plan, with agreement of land manager Public land managers consulted in implementation planning	2018–2040
<b>Research</b>	Post-graduate and/or post-doctoral research projects commissioned with universities	Urgent research priorities identified and funded Research priorities included in Implementation Plans Research findings published by DEPI Research findings used to design implementation of conservation measures	2015 2018–2040
<b>Monitoring</b>	Monitoring program designed as part of Monitoring and Reporting Framework	Monitoring undertaken consistent with Monitoring and Reporting Framework Monitoring data used to design implementation of conservation measures	2017 – some aspects ongoing
<b>Reporting</b>	Monitoring reports  Advisory committee report on expenditure and actions  Performance review report	Reports published every 2 years or as specified in Monitoring and Reporting Framework  Reports published annually  Report published five years after Initial detailed implementation plan), then every ten years	2017–ongoing <sup>4</sup>  2017–ongoing 2021–ongoing

4 Frequency of reporting after 2040 to be determined.

## 7. REFERENCES

Ashby, E., Lunney D., Robertshaw, J. and Harden, R. (1990) Distribution and status of bandicoots in New South Wales. In: *Bandicoots and Bilbies* (eds. Seebeck, J.H., Brown, P.R, Wallis, R.L, and Kemper, C.M.), pp. 43–50. Surrey Beatty and Sons, Sydney.

Berghout, M. (2000) The Ecology of the Red Fox (*Vulpes vulpes*) in the Central Tablelands of New South Wales. PhD Thesis. Applied Ecology Research Group Division of Science and Design. University of Canberra.

Bilney, R.J., Cooke, R. and White, JG. (2010) Underestimated and severe: Small mammal decline from the forests of south-eastern Australia since European settlement, as revealed by a top-order predator. *Biological Conservation*. 143: 52–59.

Biosis (2013a). Report to Inform the Revised Sub-regional Species strategy for the Southern Brown Bandicoot. Prepared for the Department of Sustainability and Environment. Biosis Pty Ltd, Port Melbourne.

Biosis (2013b). Distributional studies of the Southern Brown Bandicoot in south-central Victoria: remote camera survey and data collation. Report for Department of Sustainability and Environment. Authors: C. McCutcheon & A. Burns, Biosis Pty Ltd, Melbourne.

Burbidge, A. A. and McKenzie, N. L. (1989) Patterns in the modern decline of Western Australia's vertebrate fauna: causes and conservation implications. *Biological Conservation*. 50: 143–198.

Carwardine, J., O'Connor, T., Legge, S., Mackey, B., Possingham, H.P., and Martin, T.G. (2011). *Priority threat management to protect Kimberley wildlife*. CSIRO Ecosystem Sciences, Brisbane.

Coates, T.D. and Wright C.J. (2003) Predation of southern brown bandicoots *Isodon obesulus* by the European red fox *Vulpes vulpes* in south-east Victoria. *Australian Mammalogy*. 25: 107–110.

Coates, T., Nicholls, D. and Willig, R. (2008) The distribution of the Southern Brown Bandicoot *Isodon obesulus* in south central Victoria. *The Victorian Naturalist*. 125: 128–139.

DEPI (2013a) Biodiversity Conservation Strategy for Melbourne's Growth Corridors. Victorian Government, Department of Environment and Primary Industries, East Melbourne.

DEPI (2013b). Habitat compensation under the Biodiversity Conservation Strategy – Melbourne Strategic Assessment. Victorian Government, Department of Environment and Primary Industries, East Melbourne.

Dixon, J. M. (1966). Bandicoots: Partial survival in times of possible extinction. *Victoria's Resources* 8; 62–63.

DNRE (2002) *Victoria's Native Vegetation Management: A Framework for Action*, Victorian Government, Department of Natural Resources and Environment, East Melbourne.

DSE (2007) Advisory List of Threatened Vertebrate Fauna in Victoria – 2007. Department of Sustainability and Environment, East Melbourne, Victoria.

DSE (2009) *Delivering Melbourne's Newest Sustainable Communities – Strategic Impact Assessment Report*. Victorian Government, Department of Sustainability and Environment, East Melbourne.

DSE (2010) *Biodiversity Precinct Structure Planning Kit*. Report produced by The Department of Sustainability and Environment, East Melbourne.

Ecology Australia (2008). *Southern Brown Bandicoot Strategic Management Plan for the former Koo Wee Rup Swamp Area*. Ecology Australia, Fairfield.

Ecology Australia (2013). *Integrated Predator Control Strategy for the Southern Brown Bandicoot in the South-east Sub-region*. Ecology Australia, Fairfield.

GAA (2009) *Precinct Structure Planning Guidelines: Overview of Growth Area Planning*, Growth Areas Authority, Melbourne.

GAA (2012) *Growth Corridor Plans*, Growth Areas Authority, Melbourne.

Gould, J. (1845) *The Mammals of Australia*, Volume 1. (The author) London.

Haby, N. and K. Long (2005). *Recovery Plan for the Southern Brown Bandicoot in the Mount Lofty Ranges, South Australia, 2004 to 2009*. Department of Environment and Heritage. Adelaide: Department of Environment and Heritage.

Johnson, C. (2007) *Australia's Mammal Extinctions – A 50000 Year History*. Cambridge University Press, Port Melbourne.

Kinnear, J.E., Onus, M.L. and Bromilow, R.N. (1988) Fox control and rock wallaby population dynamics. *Australian Wildlife Research*. 15: 435–450.

Lechner, A. (2006). Population Viability Analysis of the Southern Brown Bandicoot in the Greater Melbourne Area. M.Sc. Thesis. RMIT University, Melbourne.

Lunney, D. and Leary, T. (1988) The impact on native mammals of land use changes and exotic species in the Bega district, New South Wales, since settlement. *Australian Journal of Ecology*. 13: 67–92.

Maxwell, S., Burbidge, A.A. and Morris, K. (1996) *The 1996 Action Plan for Australian Marsupials and Monotremes*. Australian Marsupial and Monotreme Specialist Group, IUCN Species Survival Commission, Canberra.

Menkhorst, P. and Seebeck, J. (1990) Distribution and conservation status of bandicoots in Victoria. In *Bandicoots and Bilbies* Surrey Beatty & Sons Pty Ltd. Chipping Norton NSW.

Paull, D.J. (2003) Habitat Fragmentation and the Southern Brown Bandicoot *Isodon obesulus* at Multiple Spatial Scales. PhD Thesis, School of Physical, Environmental and Mathematical Sciences, University of New South Wales.

Practical Ecology (2011) *Southern Brown Bandicoot Sub-regional Species Strategy*. Technical report and recommendations. Practical Ecology, Preston.

Short, J. and Smith, A. (1994) Mammal Decline and Recovery in Australia. *Journal of Mammalogy*. 75: 288–297.

Strahan, R. (1995) *The Mammals of Australia*. Australian Museum/Reed New Holland, Sydney.

Victorian Government (2009) *Delivering Melbourne's Newest Sustainable Communities – program report*. Victorian Government, Department of Planning and Community Development, East Melbourne.

Zenger, K.R., Eldridge, M.D.B. and Johnston, P.G. (2005) Phylogenetics, population structure and genetic diversity of the endangered southern brown bandicoot (*Isodon obesulus*) in south-eastern Australia. *Conservation Genetics*. 6: 193–204.





