

GILBERT'S POTOROO

(Potorous gilbertii)

Recovery Plan

By Jackie Courtenay and Tony Friend for the Gilbert's Potoroo Recovery Team

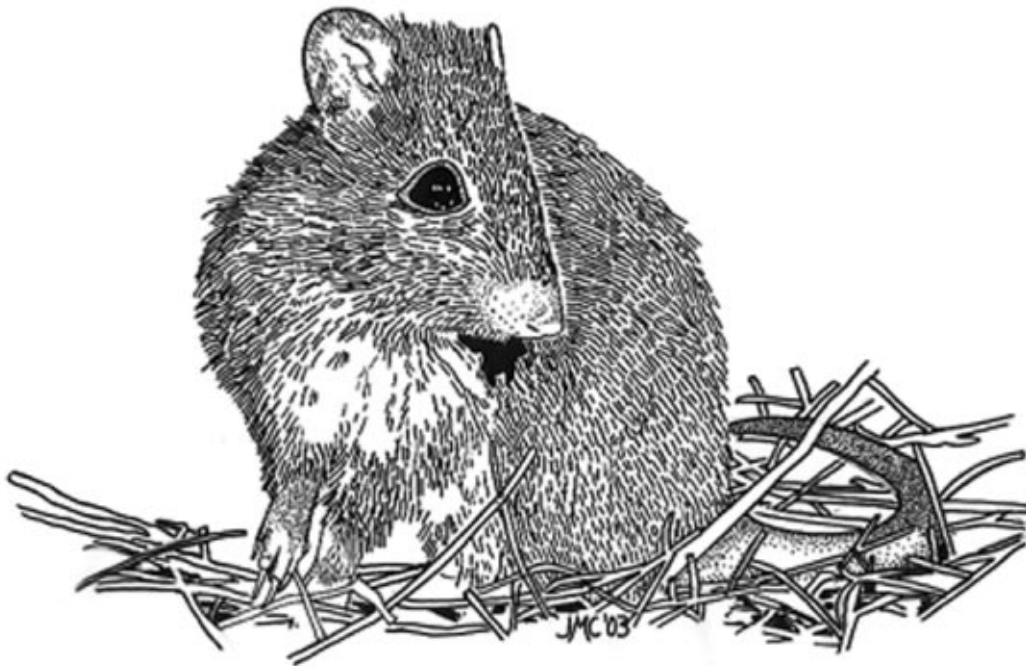


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**GILBERT'S POTROO RECOVERY PLAN July 2003-
June 2008**

by

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FOREWORD

Recovery Plans (RPs) are developed within the framework laid down in Department of Conservation and Land Management (CALM) Policy Statements Nos 44 and 50.

Recovery Plans delineate, justify and schedule management actions necessary to support the recovery of threatened species and ecological communities. The attainment of objectives and the provision of funds necessary to implement actions is subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery Plans do not necessarily represent the views or the official position of individuals or organisations represented on the Recovery Team.

This RP was approved by the Department of Conservation and Land Management, by the Conservation Commission of Western Australia and by the Minister for the Environment. Approved RPs are subject to modification as dictated by new findings, changes in status of the taxon or ecological community and the completion of recovery actions. The provision of funds identified in this Recovery Plan is dependent on budgetary and other constraints affecting CALM, as well as the need to address other priorities.

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Information in this Recovery Plan was accurate at July 2003.

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SUMMARY

Potorous gilbertii, Gilbert's potoroo

Family:	Potoroidae
CALM's Region:	South Coast
CALM's District:	Albany
Shires:	City of Albany and other South Coast shires
Recovery Team:	Gilbert's Potoroo Recovery Team
Current status of taxon:	Critically Endangered
Habitat requirements:	Dense, long-unburnt vegetation

Recovery criteria:

This Recovery Plan will be deemed successful if:

- the number of individuals known to be alive in the wild remains stable or increases, and
- the species is found at, or successfully reintroduced to, at least one other location

This RP will be deemed to have failed if:

- the estimated total number of mature individuals declines by more than 20 per cent within five years.

Recovery actions:

1. Protect the existing wild population and habitat
2. Increase understanding of ecology and population biology of Gilbert's potoroo to underpin management strategies
3. Search for new populations of Gilbert's potoroo outside Two Peoples Bay
4. Establish and maintain a captive breeding colony of Gilbert's potoroo
5. Develop techniques to enhance the reproductive potential of Gilbert's potoroo
6. Enhance the breeding capacity of Gilbert's potoroo
7. Extend the range of Gilbert's potoroo through translocation of animals to suitable habitat outside Two Peoples Bay
8. Secure ongoing funding for the implementation of the recovery actions

Benefits to other species

Gilbert's potoroo is the only extant species of *Potorous* in Western Australia, where it is endemic. It is the only potoroid in the high rainfall area of far south western Australia. It digs for fruiting bodies of hypogean, mycorrhizal fungi, which are essential symbionts of many vascular plants, and disperses the spores. Two Peoples Bay Nature Reserve is also home to four threatened bird species including the noisy scrub-bird (which also survived only on Mt Gardner) and the reserve contains a rich flora that includes four threatened species. Management for Gilbert's potoroo, including fox and cat control, protection of unburnt bush from wildfire and dieback hygiene and will be compatible with the other conservation values and coexisting species will benefit. Indeed, it is possible that management for other conservation values enabled Gilbert's potoroo to survive there.

International obligations

As Gilbert's potoroo is not listed under any international agreement, the implementation of Australia's international environmental responsibilities is not affected by this plan.

Affected interests

All land on which Gilbert's potoroos are known to survive is under the management of the Department of Conservation and Land Management. This Department is heavily involved in the implementation of this plan, through its commitment to the control of introduced predators, fire management in nature reserves and National Parks.

Role and interests of indigenous people

The Department of Conservation and Land Management is in active consultation with indigenous communities in the region affected by this plan. Implementation of relevant recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region.

Social and economic interests

The implementation of this recovery plan is unlikely to cause significant adverse social and economic impacts.

Cost, first three years: \$1 792 595

1. BACKGROUND

1.1 History and taxonomy of taxon

Gilbert's potoroo, *Potorous gilbertii* (Gould, 1841), is a small macropodoid marsupial in the family Potoroidae. Adults range from 900 g to 1200 g and there is little sexual dimorphism. The body, but not the tapered tail, is densely furred.

John Gilbert collected the first specimens of Gilbert's potoroo at "King George's Sound" in 1840 and alerted his employer John Gould that it was a distinct form. A small number of specimens were subsequently collected from the Albany region, the last in the 1870s. This was the last official record of the species and by 1909 it was believed to be extinct (Shortridge, 1910). Gilbert's potoroo was rediscovered at Two Peoples Bay Nature Reserve, 35km east of Albany, in December 1994 by Elizabeth Sinclair (Sinclair, Danks & Wayne, 1996).

The species was described by Gould (1841) as *Hypsiprymnus gilbertii*. He noted that it "closely resembles *Hypsiprymnus murinus*" (= the long-nosed potoroo, *P. tridactylus* (Kerr, 1792)). Calaby (1971) treated it as a subspecies, *P. t. gilbertii*, of the long-nosed potoroo, as did Seebeck and Rose (1988) and Seebeck, Bennett and Scott (1989). Ride (1970) and Johnston (1995), however, considered it fully synonymous with *P. t. tridactylus* of south eastern mainland Australia.

The skull of *P. gilbertii* is smaller than that of *P. tridactylus* but is relatively broader, especially (as noted by Gould) in the maxillary region. The rostrum is very inflated both anterior to the incisors and above the molar row. The adult premolar is smaller in *P. gilbertii* and is flexed in appearance with a shelf-like extension on the anterior lingual side. All the molar teeth are relatively smaller in *P. gilbertii* but the palate is broader (Courtenay, unpublished).

Sinclair and Westerman (1997) used allozyme electrophoresis and sequence analysis of the cytochrome *b* gene to examine phylogenetic relationships of extant potoroos. Their two data sets are highly concordant. Gilbert's potoroo differs from the two other partly sympatric taxa, *P. longipes* and *P. tridactylus* from south-eastern Australia by the same order of magnitude as they differ from each other. Sinclair and Westerman (1997) conclude that there are three potoroo lineages - *P. gilbertii*, *P. longipes* and a *P. tridactylus* group and that Gilbert's potoroo should be referred to as *Potorous gilbertii* (Gould, 1841). On the basis of chromosome morphology, Sinclair *et al.* (2000) concluded that *P. gilbertii* may be more closely related to *P. tridactylus* than to *P. longipes*.

1.2 Distribution and habitat

Gilbert's potoroo is now known only from the Mount Gardner headland at Two Peoples Bay (Figure 1). Within that small area (1000 ha), it occurs in at least four separate patches of long-unburnt, dense shrubland on the valley slopes. The floristic and structural composition of these core habitat patches is largely uniform and can be described as follows: *Melaleuca striata* and *M. uncinata* shrubland between 1.5-2 m tall with 70-100% canopy cover, with a dense layer of sedges including *Lepidosperma* sp. and *Anarthria scabra* beneath. The only detailed historic account records the species living in dense vegetation of different species composition lower in the landscape. The original collector, John Gilbert (quoted by Gould, 1863) reported that the Potoroo was found in "the dense thickets of spearwood and rank vegetation bordering swamps and running streams" and that it was "the constant companion" of the Quokka (*Setonix brachyurus*). Quokka populations occur in all areas on Mt Gardner where potoroos have been found. Vegetation that forms potoroo habitat at Two Peoples Bay

has not been burnt for at least fifty years and it is likely that long-unburnt areas are necessary to support the species.

Gilbert's potoroo was apparently locally abundant in the vicinity of King George Sound in the 19th century. John Gilbert wrote in letters to John Gould (1863) that "immense numbers" could be captured by Aborigines in a single afternoon. George Masters obtained specimens in 1866 and 1869 between King George Sound and the Salt (Pallinup) River to the east of Albany and William Webb took one individual at "King George's Sound" sometime between 1874 and 1879. Only one modern specimen is known to have been taken outside the Albany area. It is an unsexed skull, collected outside Brides Cave near Margaret River. The collector and date are unknown, but the specimen, part of the Shortridge collection, is now held in the National Museum in Wales (C. Fisher, personal communication).

Sub-fossil specimens have been collected from cave deposits in the Margaret River area (for example Mammoth, Museum and Brides Caves) on the Leeuwin-Naturaliste ridge. Specimens from Devil's Lair have been dated to $12\,175 \pm 225$ BP (Dortch and Merrilees, 1971). Specimens have also been found at Yanchep Caves (Glauert, 1948). Apart from the specimen found near Brides Cave, which suggests that the species occurred recently on the Leeuwin-Naturaliste Ridge, there is no indication of its original distribution through the south west. It is possible, although unlikely, that other populations have persisted in some undisturbed areas along the south coast.

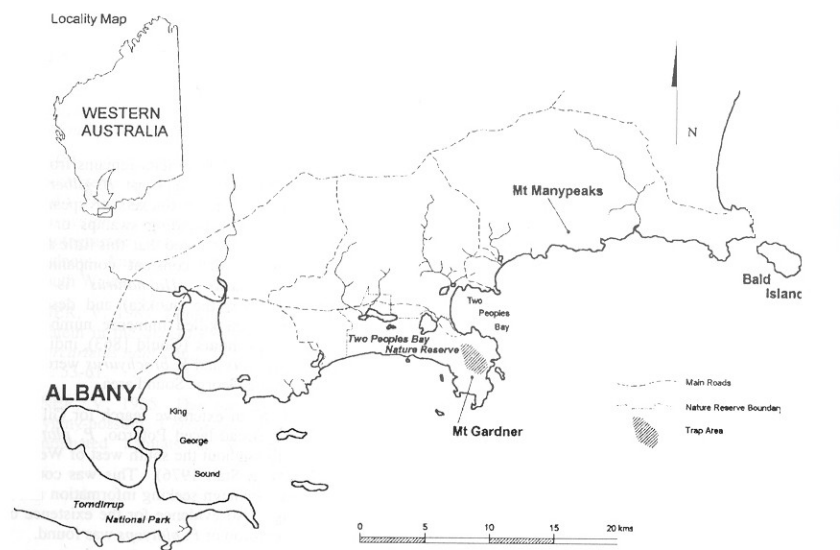


Fig 1. Map showing the location of Two Peoples Bay Nature Reserve and trapping area.

1.3 Biology and ecology

Reproduction and development

Gestation in *P. tridactylus* is the longest known for any marsupial at 38 days, or 29 days for an embryo that has been in diapause (Shaw & Rose, 1979). Females are found in the wild carrying pouch young throughout the year with two birth peaks following breeding seasons in early spring and late summer (Johnston, 1995). Seebeck (1992) reported that breeding in captive Long-footed Potoroos (*Potorous longipes*) occurs only in the second half of the year, and no young have been born in captivity earlier than June. This is supported by field studies that found a strong peak of births in the July-September quarter (Green & Mitchell, 1997).

There is little evidence of seasonality in production of young by Gilbert's potoroo. In the wild, small pouch young (≥ 30 mm crown-rump length) have been recorded in all months of the year. Captive-bred young have been born in February (1), April (2), August (1), October (1), and December (3). Oestrus length in one captive female has been estimated at around 41-43 days (Terry Fletcher, pers. comm.)

Gilbert's potoroos exhibit embryonic diapause. A female brought into captivity with a small pouch young that was subsequently lost produced a new young without having contact with a male. A second female that had been separated from the male shortly after giving birth produced another young immediately after the first exited the pouch, again without having any further contact with a male.

In *P. tridactylus* females become sexually mature by the end of their first year and have been known to continue breeding in captivity for 7 to 10 years (Ullman & Brown, 1983). Age at sexual maturity for Gilbert's potoroo is known only approximately. In captivity, one male of known age sired his first young at about 14 months, however sperm were not detected in the urine of another captive male until two years of age. Females are believed to become sexually mature at about 12 months of age. One wild caught female, estimated on the basis of tooth eruption to be about 18 months of age, was carrying a small pouch young and had evidence of a young at heel. This suggested that she had been sexually mature for at least six months. Pairings of certain adult animals in captivity have proven infertile, even though both the male and the female have produced young with other partners. Gilbert's potoroos may therefore exhibit a monogamous breeding system similar to that postulated for the Long-footed Potoroo, *Potorous longipes* (Scotts & Seebeck, 1989). If this is the case, it has important implications for the management of the captive colony. Genetic studies of the wild population may shed some light on this question, but recent attempts to develop paternity analysis techniques have been unsuccessful (Sinclair & Friend, 2000).

Young in captivity are first observed out of the pouch at around 150 g body weight and achieve permanent pouch exit about five days to a week later at around 190 g. Young then gain on average 6 g per day over the next few months. The teeth of young at pouch exit include the deciduous upper and lower central incisors, the deciduous premolar and M¹. The second deciduous incisor and M² are erupting. The canine begins eruption just prior to weaning. The permanent premolar and M⁵ erupt around two years of age, and the eruption of and wear on these teeth can assist in developing age estimates for trapped animals.

There are no published records of reproductive senescence in potoroids, although an unpublished report on testicular biopsies of potoroos suggested that testicular senescence was a possible factor in the testicular regression and apparent infertility of captive *P. tridactylus* and *P. longipes* males (Temple-Smith & Taggart, 1994). The maximum known age at which a captive male Gilbert's potoroo has mated successfully is six years. The oldest *P. gilbertii* female of known age to have produced young in captivity was five years old at the time of the birth. At the time of writing, the oldest wild female *P. gilbertii* of known age was seven years old and had a young at heel. Several wild females judged from tooth wear to be over five years of age have been observed without sign of recent parturition, so it is possible that fecundity declines in older females.

Longevity

Seebeck and Rose (1988, p. 725) noted that "Potoroids are relatively long lived with life spans of more than seven years in the wild and up to twelve years in captivity". Gilbert's potoroos can live to well over seven years of age in the wild. A male still alive at the time of writing is at least ten years old, as he was at least three years old (estimated from tooth eruption and wear) when first recorded seven years ago. In a long term study of *P. tridactylus* in Tasmania, one individual male was known to survive in the wild for 7+ years and this was thought to be close to the maximum for the species (Guiler & Kitchener, 1967). Captive *P. gilbertii* have achieved similar ages. An old male died recently aged at least eight

years, and a female at least one year old when brought into captivity is still alive eight years later.

Spatial organisation

Trapping and radio-tracking has shown that Gilbert's potoroos live in small groups in the patchy habitat. These colonies are isolated from each other but dispersing sub-adult animals and some older males move between them. Amongst resident animals there is little overlap in home range between animals of the same sex, but there is strong overlap between males and females. Long-nosed Potoroos (Long, 2001) and Long-footed Potoroos (Green, Mitchell & Tennant, 1998) exhibit similar spatial organization. Gilbert's potoroo males have home ranges of 15-25 ha (measured over two weeks in summer), whereas females, young-at-heel and sub-adult animals of both sexes move within only 3-6 ha (Friend, 2000).

Diet

Like the Long-footed Potoroo, the diet of Gilbert's potoroo consists almost entirely of fungi. A study of dietary composition based on faecal analysis (Nguyen, 2000) found that fungal material made up more than 90% of the diet, the remainder being comprised of sand and root material that had apparently been ingested incidentally, as well as invertebrates and occasionally seeds from fleshy fruits. While 44 species of fungi were consumed in total, five species were found to be consumed by over 60% of animals in all seasons of the year.

Abundance

The number of known individuals depends on both the actual population and the trapping effort. Trapping effort increased in 1999 and the number of known animals has risen from about eight to about 17 in 2003, but there has been little change in trap success, indicating no change in the total population. Trapping is conducted in all the major sites of suitable habitat and it is likely that the majority of Gilbert's potoroos have access to established trap sites. It is very unlikely that there are more than 30 animals in the Mount Gardner population.

1.4 Threatening processes

Fire

The only known wild population of Gilbert's potoroo exists in dense, long unburnt vegetation that is potentially highly vulnerable to wildfire. Fire exclusion is thus an extremely high priority in the protection of the wild population, and the captive colony was established at least partly to provide insurance against the loss of the single known population through a catastrophic fire event.

Feral predators

Gilbert's potoroo is within the Critical Weight Range (35 g-5 kg) of mammals thought to be most susceptible to decline (Burbidge & McKenzie, 1989). It is in the prey size range of both foxes and cats, both of which are known to occur in the Two Peoples Bay area. Foxes can be controlled using dried meat or egg baits impregnated with 1080. No suitable baits are yet available to control feral cats that do not also put potoroos at risk. Dietary analysis of the gut contents and faeces of a feral cat trapped in the West 6 area of Mt Gardner in 2001 revealed that it had consumed both quenda (*Isodon obesulus*) and noisy scrub-bird (*Atrichornis clamosus*). Control of feral cats would thus also be beneficial to other threatened mammals and birds in the area.

*Dieback disease (*Phytophthora cinnamomi*)*

Potoroos are believed to be present only in areas of the Reserve that are free of *Phytophthora* infection. Dieback disease can cause considerable changes to the floristic structure of the habitat. Gilbert's potoroo feeds primarily on hypogean fungi, many of which are mycorrhizal. Plant dieback disease is considered to be a major threat to the continued survival of the

potoroo by altering vegetation structure or eliminating species that are hosts to the mycorrhizal fungi on which they feed.

Clearing of vegetation adjacent to Two Peoples Bay

The population of Gilbert's potoroo on the Mount Gardner headland has the potential to expand through the dispersal of young through adjacent bushland corridors into suitable habitat nearby (especially near Mount Manypeaks). Some of this linking bushland occurs on private land. Unless these corridors are protected from clearing, the chance of successful dispersal to new areas will be very small. Ideally, the strip of bushland linking Two Peoples Bay NR with the Boulder Hill area should be protected from fire and expanded by rehabilitation of a small amount of grazing land to shrubland.

The whole of Two Peoples Bay Nature Reserve is affected, or potentially affected, by fire, dieback and feral predators. In addition, all possible mainland translocation sites in the south west of Western Australia are affected by feral predators and at least potentially affected by fire and/or dieback. Before any translocations can be contemplated, any potential site will need to be prepared to minimise the impact of these processes and ongoing management of threatening processes will be required.

1.5 Conservation status

Gilbert's potoroo is known only from a single, very small population on Mount Gardner, in Two Peoples Bay Nature Reserve, near Albany, Western Australia. The known wild population numbers fewer than 20 individuals and occurs in an area of about 1000 ha.

Potorous gilbertii is listed as fauna that is likely to become extinct or is rare (Western Australian *Wildlife Conservation Act 1950*) and has been ranked as Critically Endangered by the WA Threatened Species Scientific Committee. It is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It is listed as Critically Endangered in *The 1996 Action Plan for Australian Marsupials and Monotremes* (Maxwell, Burbidge & Morris, 1996) and in the *2004 IUCN Red List of Threatened Species* (IUCN 2004) according to criteria C2b (Number of mature individuals is less than 250, declining and all individuals are in a single subpopulation) and D (Number of mature individuals is less than 50).

1.6 Strategy for recovery

The keys to conserving Gilbert's potoroo are to ensure that the single known wild population persists, and to increase the number of locations at which the species occurs. This will require:

- monitoring of known populations;
- undertaking protective actions including fire exclusion, feral animal control and dieback hygiene;
- searching for additional populations, especially outside Two Peoples Bay;
- undertaking assisted reproduction techniques to enhance the reproductive potential of the species; and
- creating new populations through translocation.

Implementation of the Recovery Plan is overseen by the Gilbert's Potoroo Recovery Team. Membership of the Recovery Team at June 2003 was as follows:

Current member	Affiliation	Role
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Alan Danks (Chair)	CALM's South Coast Region	Regional Leader of Nature Conservation (former Reserve Manager, Two Peoples Bay)
Raquel Carter	WWF Australia	Threatened Species Network WA Co-ordinator
Jackie Courtenay	Consultant Wildlife Biologist	Former Project Officer
Ron Dorn	Gilbert's potoroo Action Group	Community Group representative
Terry Fletcher	Perth Zoo	Curator of Research, Perth Zoo, Marsupial reproductive biologist
Tony Friend	CALM's Science Division	Project Leader
Nicky Marlow	CALM's Science Division and Western Australian Threatened Species and Communities Unit	Science Division and WATSCU representative
Alan Needham	Edith Cowan University, Applied Science	Marsupial physiologist, student supervisor
Vic Smith	Retired veterinarian, South Coast Community member	Community representative
David Taggart	Research Scientist, Royal Zoological Society of South Australia.	Co-ordinator, Cross-fostering program for Gilbert's potoroo

1.7 Benefits to other species

Gilbert's potoroo is the only extant species of *Potorous* in Western Australia, where it is endemic. It is the only potoroid in the high rainfall area of far south western Australia. It digs for fruiting bodies of hypogeal, mycorrhizal fungi, which are essential symbionts of many vascular plants, and disperses the spores. Two Peoples Bay Nature Reserve is also home to four threatened bird species including the Noisy Scrub-bird (which also survived only on Mt Gardner) and the Reserve contains a rich flora that includes four threatened species. Management for Gilbert's potoroo, including fox and cat control, protection of unburnt bush from wildfire and dieback hygiene and will be compatible with the other conservation values and coexisting species will benefit. Indeed, it is possible that management for other conservation values enabled Gilbert's potoroo to survive there.

1.8 International obligations

As Gilbert's potoroo is not listed under any international agreement, the implementation of Australia's international environmental responsibilities is not affected by this plan.

1.9 Affected interests

All land on which Gilbert's potoroos are known to survive is under the management of the Department of Conservation and Land Management. This Department is heavily involved in the implementation of this plan, through its commitment to the control of introduced predators, fire management in nature reserves and National Parks.

1.10 Role and interests of indigenous people

The Department of Conservation and Land Management is in active consultation with indigenous communities in the region affected by this plan. Implementation of relevant

recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region.

1.11 Spatial data

A description of location and habitat requirements is provided but adequate spatial data/maps have not been included as these are not yet available. Such data will be collated during the first year of the operation of this plan.

1.12 Social and economic interests

The implementation of this recovery plan is unlikely to cause significant adverse social and economic impacts.

1.13 Evaluation of the Plan's performance

The Department of Conservation and Land Management, in conjunction with the Gilbert's Potoroo Recovery Team, will evaluate the performance of this recovery plan. The plan is to be reviewed within five years of its implementation. Any changes to management/recovery actions will be documented accordingly.

2. HABITAT CRITICAL TO SURVIVAL

Critical habitat is habitat identified as being critical to the survival of a listed threatened species or community. Habitat means the biophysical medium or media: (a) occupied (continuously, periodically or occasionally) by an organism or group of organisms; or (b) once occupied (continuously, periodically or occasionally) by an organism, or group of organisms, and into which organisms of that kind have the potential to be reintroduced (EPBC Act, 1999).

In the case of Gilbert's potoroo, it comprises:

- areas occupied by Gilbert's potoroos;
- areas not currently occupied by Gilbert's potoroos due to recent fire but capable of supporting Gilbert's potoroo populations when sufficiently recovered;
- areas of natural vegetation through which Gilbert's potoroos can move from one occupied area to other areas;
- areas of suitable vegetation, especially if quokka (*Setonix brachyurus*) populations are present, within the extent of occurrence (IUCN, 2001) of Gilbert's potoroo in which undiscovered populations may exist; and
- areas of suitable vegetation, especially if quokka populations are present, within the extent of occurrence (IUCN 2001) of Gilbert's potoroo into which Gilbert's potoroo could be reintroduced.

3. GUIDE FOR DECISION MAKERS

Although Gilbert's potoroos have probably inhabited the Mount Gardner headland for hundreds of years, they are very vulnerable to disturbance, particularly fire, and any other process that might remove their cover by damaging the vegetation. Potoroo numbers are so low at Two Peoples Bay that if all habitat is occupied, any removal of core habitat vegetation could jeopardise the population.

Possible future actions that may constitute 'significant impact' (EPBC Act) on Gilbert's potoroo or its habitat include:

- any action that increases the likelihood of wildfire in Gilbert's potoroo habitat;
- any action that increases the likelihood of predation of Gilbert's potoroos by introduced species;
- any action that increases the rate of spread of *Phytophthora* infection in Gilbert's potoroo habitat;
- any action that reduces the ability of Gilbert's potoroos in established populations to disperse safely to other habitat; and
- any action that causes the loss of suitable habitat for reintroduction, or the loss of quokka populations from such areas.

4. RECOVERY OBJECTIVE AND CRITERIA

4.1 Recovery objective

The objective of the Gilbert's Potoroo Recovery Plan is to increase both the numbers of individual Gilbert's potoroos known to be alive in the wild and the number of locations in which they occur.

4.2 Criteria for success

This Recovery Plan will be deemed successful if:

- the number of individuals known to be alive in the wild remains stable or increases and
- the species is found at, or successfully reintroduced to, other locations.

4.3 Criteria for failure

This Recovery Plan will be deemed to have failed if:

- the estimated total number of mature individuals declines by more than 20 per cent within five years.

5. RECOVERY ACTIONS

Action 5.1: Protect the existing wild population and habitat

Action 5.1.1 Conduct aerial and/or ground baiting to control foxes.

Fox baiting using 1080 in eggs began in 1988 in the western parts of Two Peoples Bay NR and was extended to most tracks within the reserve in subsequent years. Baiting intensified in 1995 after the rediscovery of Gilbert's potoroo in November 1994. With the expansion of CALM's *Western Shield* baiting program, dried meat baits increasingly became the norm, although egg baits continued to be used in boundary areas until 1998. Since 1996 the reserve has been aerielly baited four times a year, with additional baits laid by hand on boundary firebreaks and tracks monthly. Additional baits are also hand distributed on Mt Gardner tracks whenever foxes are sighted or fox sign (footprints, scats) is detected.

Responsibility:	CALM
Cost (first 3 years):	\$10200 p.a.
Priority:	High
Completion date:	Ongoing

Action 5.1.2. Investigate improved methods for feral cat control.

Cats are known to be present on Mt Gardner but their numbers and level of impact on the potoroos is unclear. Cat prints are occasionally seen on sand tracks on Mt Gardner and a feral cat was trapped in the West 6 area in 2001. Dietary analysis of the gut contents and faeces of the cat revealed that it had consumed both quenda and noisy Scrub-bird. Cat-trapping will be carried out using leghold traps set in fenced exclosures to reduce risk to non-target species, at least once a year, following the methods developed by Algar and Angus (2002). In addition, a regular monitoring system using sandpads on firebreaks and field video surveillance in trapping areas will be established and protocols developed to record and respond to sightings of feral predators. When broadscale methods of cat control become available, their usefulness at Two Peoples Bay will be assessed.

Responsibility:	CALM
Cost (first 3 years):	Yr 1 \$7440; Yr 2 \$11940; Yr 3 \$7440
Priority:	High
Completion date:	Ongoing

Action 5.1.3: Conduct fire management according to the existing plan.

The only known wild population of Gilbert's potoroo occurs in dense, very long unburnt vegetation (45-60+ years since last burnt). Fuel loads are thus very high and under even moderate conditions could result in high intensity fire behaviour which would be extremely difficult to control. While other Potoroid species such as woylies, *Bettongia penicillata* (Christensen, 1980), Tasmanian bettongs, *Bettongia gaimardi* (Johnston, 1995) and long-nosed potoroos, *Potorous tridactylus* (Seebeck, pers. comm. Jan. 2003) have been known to survive high intensity fires, the population of Gilbert's potoroo is too small to risk the loss of even a small number of the adults. Deep, damp gullies and extensive sheets of bare granite have allowed some areas to escape wildfires in the past but nevertheless, only a small proportion of an already desperately small population may survive a major wildfire and cover would be limited for several years. This could make surviving potoroos more susceptible to

predation because they lack sufficient cover to escape. Studies of hypogean fungi following fire in eucalypt forests in Tasmania (Taylor, 1991, Johnson, 1995) found that while production of sporocarps in two genera (*Mesophellia* and *Castoreum*) appeared to increase, overall species diversity decreased in the burnt areas, although the effects were short lived. The impact of fire on sporocarp productivity, and hence food supply, in the coastal heathlands where Gilbert's potoroo is found is not known, but there is a risk that reduced species diversity after fire could be detrimental to a species which is so highly dependent on fungi.

The main objective for fire management at Two Peoples Bay Nature Reserve is the exclusion of fire from the Mt Gardner area (Orr *et al.* 1995) which is necessary also for the protection of the threatened birds in the area. Important elements of the strategy include maintenance of a low fuel buffer across the isthmus to allow control of wildfires and the maintenance of access tracks within the Mt Gardner area. Water points have been installed around the mountain, and effective fire control procedures, personnel and equipment have been established within CALM's Albany District. Good working relationships are maintained with the local volunteer fire brigade. The effectiveness of the buffer and other suppression procedures were tested during a severe wildfire in December 2000. The fire was prevented from entering the Mt Gardner area.

Similar fire control strategies will need to be developed at any other locations where Gilbert's potoroo populations are discovered and at reintroduction sites.

Responsibility:	CALM
Cost (first 3 years):	\$4000 per year
Priority:	High
Completion date:	Ongoing

Action 5.1.4: Continue to follow existing dieback hygiene protocols and develop and implement new protocols.

The most serious plant diseases on Two Peoples Bay Nature Reserve are dieback diseases caused by *Phytophthora*. There is concern that these diseases could alter the structure of the habitat, adversely affecting potoroos, and eliminate many of the vascular plant hosts to mycorrhizal fungi on which the potoroos depend. These concerns have prompted a re-evaluation of the occurrence of *Phytophthora* on Mt Gardner. Because of the high conservation values of Two Peoples Bay Nature Reserve, there have been stringent rules controlling access in wet weather, and controlling all earth-moving activities and other actions that might spread the pathogen. This includes cleaning footwear after crossing infected sites during routine field work.

The chemical phosphite confers temporary immunity to *Phytophthora* in susceptible plants. CALM has developed the broad scale use of phosphite for controlling dieback disease in small populations of threatened plants in Stirling Range NP and in controlling the spread of dieback within a small area of the Fitzgerald River NP. Rates and timing of application are important in achieving adequate uptake of the chemical while avoiding negative effects on plant growth, leaf scorch, etc... This method may be applicable to control dieback in some areas of Two Peoples Bay Nature Reserve. Prior to any application of phosphite, some research would be needed to determine the effects of the chemical on the host plants and hypogean fungi which form the basis of the potoroo's food.

A new dieback hygiene and control plan will be developed by CALM Albany before December 2004.

Responsibility:	CALM
Cost (first 3 years):	\$5865 in first year, then \$3000 per year

Priority: High
Completion date: Ongoing

Action 5.1.5: Conduct regular monitoring of the main colonies on Mt Gardner.

Monitoring of the main potoroo colonies is currently conducted by cage trapping every four months. This is thought to be the longest interval that enables the capture of the same young individual twice while still with its mother, thus providing some data on development and length of pouch life. Monitoring of the main colonies will be continued on a regular basis to provide up-to-date information on the status of the population.

Responsibility: CALM
Cost (first 3 years): \$18235 in first year, then \$16235 per year
Priority: High
Completion date: Ongoing

Action 5.1.6 Undertake community education on the need for fire protection and baiting at Two Peoples Bay.

Fire protection and feral animal control are both essential to the survival and recovery of Gilbert's potoroo. Two Peoples Bay is, however, also a popular recreational area (60 000 visitors in 2001 with numbers increasing steadily). Despite adequate signage, the presence of two rangers and a visitors centre focussed on endangered species conservation, a small number of visitors light fires on the beach and bring dogs into the Reserve. Although considerable care is taken to ensure that fox baits are not distributed near recreation sites, occasional deaths of pet dogs illegally brought into the Reserve have received sympathetic coverage in the local media. A community education campaign is urgently required to raise awareness of the plight of Gilbert's potoroo and the importance of these two measures for its protection. This campaign will be implemented with the help of community groups (where possible) through the production of brochures and other actions to raise public awareness and promote a sense of local ownership of and responsibility for the potoroo.

Responsibility: Recovery Team through CALM
Cost (first 3 years): \$1870 in first year, then \$1650 per year
Priority: High
Completion date: Ongoing

Action 5.2: Increase understanding of ecology and population biology of Gilbert's potoroo to underpin management strategies

Action 5.2.1: Investigate the population biology of Gilbert's potoroo in the wild with particular emphasis on the fate of juveniles.

Although wild caught females are usually carrying pouch young, recruitment of those young to the adult population is low. Between February 1999 and December 2001, 38 young were seen in the pouch but only 12 animals in that cohort were trapped after permanently leaving the pouch. Only seven of those animals (i.e. ~20 per cent of the original pouch cohort) have been retrapped regularly. This loss of individuals, while not unusual in wild populations, represents a potential source of population increase. One or more of the following factors may be operating:

- (i) Habitat on Mount Gardner is at carrying capacity so that young can only survive when a home range becomes available through the death of an adult.
- (ii) Young are lost during pouch life.
- (iii) There is a high rate of predation after pouch exit, including during the dispersal phase.

The relative importance of these factors is of significance in any decision to harvest pouch young for cross-fostering (see Actions 5.5.4 and 5.6.2 below). If young are dying due to lack of unoccupied habitat, removal of some for cross-fostering or translocation may increase the overall number of young reaching adulthood. On the other hand, if dispersing young are subject to high rates of predation, removal of significant numbers of pouch young for cross-fostering could affect the viability of the wild population.

Studies into the dispersal and survival of juveniles are under way. As of July 2003, seven animals up to 18 months old had been fitted with transmitters and located several times each week while the transmitters remained attached. This study will continue in 2003/04.

Results of these studies will be incorporated into a model that will determine the maximum rates at which pouch young can be harvested for cross-fostering and independent young removed to captivity or translocation without threatening the viability of the wild population.

Responsibility:	CALM
Cost (over 2 years):	\$16900 first year, \$17600 second year
Priority:	High
Completion date:	2005

Action 5.2.2: Examine the ecology of the wild population including diet, habitat requirements and social organisation.

Increasing knowledge about the ecology of Gilbert's potoroo will assist both in optimising captive breeding conditions and in selecting and managing potential reintroduction sites. Diet studies (Bougher 1998, Nguyen 2000) have identified spore types found in potoroo faeces but further investigation is needed to link these spore types with the gross morphology of the fungal fruiting bodies. Field identification of truffle species of dietary importance is vital for assessing potential reintroduction sites and to assist research into the effect of *Phytophthora* on potoroo food sources (Action 5.2.3). More detailed information about feeding movements, the impact of fire on food resources, home range size, and spatial organisation will be essential in planning translocations and selecting sites. Development of captive breeding protocols may also be assisted by elucidation of the spatial and social organisation of the wild colonies.

Short-term studies of groups of potoroos in the wild using various techniques including radio-tracking, spooling, remote video and trapping will be carried out as appropriate to enhance knowledge in these areas and to answer specific questions.

Responsibility:	CALM
Cost (over 2 years):	\$21400 in first year, \$24400 in second year
Priority:	High
Completion date:	2004

Action 5.2.3: Investigate the effect of *Phytophthora* infection on habitat suitability.

The effect of *Phytophthora* infection on habitat suitability is currently unclear. In order to clarify this, dieback mapping and soil sampling need to be carried out at Two Peoples Bay to

determine the relative occurrence of Gilbert's potoroo and *Phytophthora cinnamomi*. The interaction between *Phytophthora* and the hypogean fungi which are of dietary importance to the Potoroos also needs to be determined and work in this area by specialist mycologists needs to be supported and facilitated.

Responsibility: CALM, Universities
Cost (first 3 years): \$4140 in first and second years, \$2500 in third year
Priority: Medium
Completion date: 2007

Action 5.3: Search for new populations of Gilbert's potoroo outside Two Peoples Bay

Action 5.3.1: Conduct surveys of suitable habitat in parts of the species' former range.

Surveys for further surviving populations of Gilbert's potoroo are continuing. The search to date, using hair-arching and trapping, initially concentrated on areas within 30 km of Two Peoples Bay (Gull Rock to Cheyne Beach) targeting dense habitat, especially where evidence of quokkas is found. This area has now been well searched, without success. During 2002/03, surveys were extended westwards through a project run by the Denmark Environment Centre, and eastwards by Departmental staff. As well as targeting areas of suitable habitat, the search will involve local appeals to the public to report possible sightings and these will be assessed and followed up with hair-arching if appropriate. Trapping surveys will be carried out if potoroo hair is recovered.

Responsibility: CALM
Cost (first 3 years): \$11800 in first year, \$33500 in second year, \$11300 in third year
Priority: High
Completion date: Ongoing

Action 5.3.2 Encourage community groups to conduct hair-arch surveys outside Two Peoples Bay and provide training in techniques and support for community funding applications.

Hair-arch surveys have been found to be very effective in identifying populations of mammals, including Gilbert's potoroos, in heathland on the south coast of Western Australia. These surveys are labour intensive and require skills in construction and placement of arches, recognition of appropriate habitat for placement, dieback hygiene, hair identification, hair storage and curation. A program has been implemented to train community group members in these skills to enable them to conduct hair-arch surveys in areas outside Two Peoples Bay. One group (the Denmark Environment Centre) has already obtained funding and commenced hair arch surveys in suitable habitat west of Albany. Support in the preparation and submission of funding applications to carry out community based hair-arching will continue to be provided.

Responsibility: Recovery Team through CALM, Community groups
Cost (first 3 years): \$2240 per year
Priority: High
Completion date: Ongoing

Action 5.4: Establish a self-sustaining captive breeding colony of Gilbert's potoroos for security, breeding, research and reintroduction.

Action 5.4.1 Establish and maintain one or more captive colonies of Gilbert's potoroos for breeding, research, reintroduction and security.

A captive colony of Gilbert's potoroos was established at Two Peoples Bay following the rediscovery of the species in 1994. The stated reasons for the establishment of the captive colony were to provide insurance against loss of the only known wild population (for example through a wildfire) and to provide animals for eventual reintroduction to other sites (Start & Burbidge, 1995). While the colony grew from the initial nine founders (including three pouch young or young-at-heel brought in with their mothers) to a maximum of 14 animals in 1998, reproductive rates have been much lower than anticipated. While females are capable of producing at least two young each year, some captive females have produced no offspring and only eight captive-bred young have been produced in seven years. Reasons for the depressed reproduction are unclear but various possibilities including diet, genetics (inbreeding depression), proximity and social behaviour are being investigated.

As the captive colony has not achieved the original goals using only natural breeding, the use of assisted reproduction is being examined (see Action 5.5 below). Research to develop techniques for artificial insemination in potorooids is being carried out by Perth Zoo's research section. Techniques will be developed and optimised in long-nosed potoroos at Perth Zoo before trials with Gilbert's potoroos at the Two Peoples Bay breeding facility. If successfully applied to Gilbert's potoroos, this technique will not only enable more young to be produced, but will also overcome any behavioural incompatibility and thus allow better genetic management. The feasibility of cross-fostering young from the wild is also being investigated elsewhere (see Actions 5.5.3 & 5.5.4 below) to increase the overall reproductive rate and possibly to enhance the genetic variability in the captive colonies. Cross-fostering could also be used to increase the rate of output of young produced in captivity either by natural means or by artificial insemination.

The establishment of a self-sustaining captive population which can produce sufficient animals to reintroduce into habitat outside the Mt Gardner area is considered a vital strategy in the recovery of Gilbert's potoroo. While cross-fostering from the wild will be used to adapt the technique to Gilbert's potoroo, removal of large numbers of pouch young from the few wild females may threaten the viability of the Two Peoples Bay population.

Responsibility:	CALM, Perth Zoo
Cost (first 3 years):	\$59080 in first year, \$65080 in second year, \$61080 in third year
Priority:	High
Completion date:	Ongoing

Action 5.4.2 Establish a Captive Management Group for Gilbert's potoroo.

The Captive Management Group was established in December 2000 and operates as a working group of the Recovery Team to provide advice on captive breeding aspects of the recovery program. As of July 2003 the Group comprised Dr Tony Friend, Gilbert's potoroo project leader (convenor), Dr Jackie Courtenay, project officer 1996-1998; Dr Terry Fletcher, Curator of Research at Perth Zoo and Dr David Taggart, Research Scientist with the Royal Zoological Society of South Australia. Additional members may be included if further expertise is required.

Responsibility:	Recovery Team through CALM
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Cost: \$2620 per year
Priority: High
Completion date: Ongoing

Action 5.4.3 Carry out nutritional analysis of at least five species of truffle-like fungi eaten by Gilbert's potoroo and redesign captive diet.

As noted above, in the wild Gilbert's potoroo is highly dependent on fungi. The captive potoroos, however, have been maintained on fruits, vegetables, grains, nuts and mealworms, in common with captive colonies of other potoroos in Australia and elsewhere. Since August 2001, the diet has been supplemented with a small proportion of truffles. The low rate of reproduction and some health problems (for example, oxalosis) experienced by the animals could be related to inadequacies in the captive diet. In order to develop an improved captive diet, nutrient analysis of several species of truffles has been carried out. A series of nutrient analyses has been selected through consultation with an animal nutritionist and wildlife veterinarians. The series of analyses selected require a minimum of 50g dry weight of fruiting bodies of each species. In 2002/03, three species were run through the full set of analyses, and two species through a smaller set of analyses as insufficient quantities were available for the full set. Further material of these and other species will be collected and analysed in 2003/04. The results of the nutritional analysis will be used in a redesign of the captive diet.

Responsibility: CALM
Cost (one year only): \$10650 in first year only
Priority: High
Completion date: 2004

Action 5.4.4 Continue to research, improve and develop husbandry techniques to maximise the health and reproductive potential of captive Gilbert's potoroos.

Improvement in husbandry techniques is required to ensure that the health and reproductive potential of any young born in captivity are maximised. Since at least some captive-born or cross-fostered young will need to be maintained in captivity over the longer term, improved husbandry to enable those animals to reproduce successfully and minimise health concerns is essential. While some of the health problems experienced in the captive colony may be the result of genetic factors, research will continue into improving the artificial diet, disease patterns, and hygiene. Social behaviour will also be investigated in an attempt to identify and overcome behavioural incompatibilities. Methods for monitoring oestrus from progesterone levels in faeces will also be investigated.

Responsibility: CALM, Perth Zoo
Cost (first 3 years): \$3000 per year
Priority: High
Completion date: 2007

Action 5.4.5 Investigate and manage veterinary issues of importance to the captive husbandry of Gilbert's potoroo.

A number of veterinary issues must be considered when maintaining Gilbert's potoroo in captivity. There is concern that the captive Gilbert's potoroos may be immunosuppressed. Mycobacteriosis and cryptococcosis, both of which are typically diseases of

immunosuppressed animals have been diagnosed in the captive animals. These diseases can also occur in healthy individuals that are subjected to a heavy challenge with the causative organisms. The fact that blood samples taken from the animals have had consistently low leucocyte counts compared with other species of potoroos, however, raises the possibility that the animals are immunosuppressed. Renal oxalosis has caused the deaths of several animals. While this condition appears to be at least partly of genetic origin, affected animals require veterinary management. Investigations into the causes and management of the various health conditions will continue and ongoing veterinary advice sought to improve the diet, hygiene and handling protocols to minimise stress and improve animal health.

Responsibility:	CALM, Perth Zoo
Cost (first 3 years):	\$6050 per year
Priority:	High
Completion date:	Ongoing

Action 5.4.6 Investigate the inheritance of oxalate poisoning and develop DNA markers to screen individuals for the captive breeding program.

Six captive individuals have died, and were diagnosed with severe kidney damage due to oxalate crystal precipitation, known as Renal Oxalosis. The disease is typically diagnosed by high levels of urinary glycolate. Previous cases of oxalate poisoning in marsupials were correlated with external sources for the oxalate, but so far no external source of oxalate has been found in the potoroo enclosures. Renal oxalosis has yet to be observed in the wild population.

In humans, both genetic and dietary influences are attributed to the disease. Two types of inherited disorders of oxalate metabolism have been identified, with the most common form causing dysfunction of the enzyme Alanine Glyoxylate Aminotransferase (AGT). AGT is involved in intermediary steps in amino acid and oxalate metabolism. All abnormalities of AGT resulting in hyperoxaluria are inherited with an autosomal recessive pattern of inheritance. There are other causes of oxalosis including vitamin B6 deficiency, hypercalcaemia, vitamin C toxicity, and enteric disease leading to the absorption of excessive amounts of oxalate. However, the possibility of a genetically inherited disease in potoroos should be considered due to the diagnosis of oxalosis in five captive animals, of which four are related (mother and three offspring). The inheritance of renal oxalosis needs to be investigated and DNA markers developed to provide the capability to screen individuals without collecting urine. This will allow study of the interaction between expression of symptoms, diet and genetic disposition to the disease.

Responsibility:	CALM, Universities
Cost (first 3 years):	\$12050 in second year only
Priority:	High
Completion date:	2004

Action 5.4.7 Revise and update the draft Husbandry Manual.

A Draft Husbandry Manual was written in 1998 (Courtenay 1998a) detailing practices for animal housing, handling, diet, colony composition, breeding, and veterinary concerns. Husbandry methods have been revised over the past five years in response to health concerns and to accommodate research, for example into faecal hormone levels. It is essential that the Manual be revised to reflect these changes, especially now that the colony is divided between two institutions. The Husbandry Manual will be revised and updated by July 2004 and then reviewed every two years thereafter until termination of the captive management component

of the recovery plan. The aim of this document is to provide detailed information on all aspects of captive breeding to assist those involved in captive breeding and conservation of this species and to ensure best practice husbandry of Gilbert's potoroo wherever they are held captive.

Responsibility: Recovery Team through CALM
Cost (first 3 years): \$2050 in first year
Priority: High
Completion date: July 2004

Action 5.4.8 Establish and maintain a studbook for the Gilbert's potoroo.

A studbook which records the births, deaths, pairings and veterinary history of the captive animals has been established and is maintained at Two Peoples Bay.

Responsibility: CALM
Cost (first 3 years): \$975 per year
Priority: High
Completion date: Ongoing

Action 5.5: Develop techniques to enhance the reproductive potential of Gilbert's potoroo.

Action 5.5.1 Gather basic information on the reproductive biology, growth and development of Gilbert's potoroo in captivity at Two Peoples Bay and Perth Zoo and other sites as relevant to the application of reproductive techniques and breeding enhancement for reintroduction purposes.

Data on the reproductive biology of Gilbert's potoroo is extremely limited. Over the past eight years since the rediscovery data have been collected on a limited number of wild and captive pouch young which have enabled estimates of length of pouch life, age at pouch exit and weaning, and reproductive potential to be made. It has also been determined, through observation of captive animals, that Gilbert's potoroos exhibit embryonic diapause. This feature will further enhance the effectiveness of cross-fostering techniques in increasing reproductive potential as the target female does not have to wait to come into oestrus and mate again before producing a new young to replace the one removed for cross-fostering. More detailed information collected from a larger sample of animals is, however, required. Reproductive data on both males and females will be collected opportunistically from all animals currently held in captivity and from all animals captured in the wild.

Responsibility: CALM
Cost (first 3 years): Staff time costed elsewhere.
Priority: High
Completion date: Ongoing

Action 5.5.2 Trial and review natural reproduction options at Two Peoples Bay.

Natural reproduction trials have been ongoing at Two Peoples Bay since the colony was established in December 1994. Single male/female pairings and groups containing one male and two or three females have produced offspring, although at a much slower rate than

observed in the wild. Groups of several males with several females have not yet been trialed because the risk of severe aggression between males in the relatively small enclosures was considered too high. Compatibility between males and females appears to be an issue as pairings of individuals that have produced young with other partners commonly fail. In addition, only one pairing (that of #10 and #3, both now deceased) produced young on more than one occasion. Other pairings failed to produce a second young after successfully reproducing once. Further research into reproductive behaviour is therefore required. The success of captive breeding trials will be reviewed on a regular basis and methods revised in accordance with success of trials and other data from behavioural and ecological studies.

Responsibility:	CALM
Cost (first 3 years):	Staff time costed elsewhere.
Priority:	High
Completion date:	Ongoing

Action 5.5.3 Develop techniques for cross-fostering pouch young between potoroid species.

Cross-fostering was initially proposed and tested successfully in macropodids over 30 years ago (Merchant & Sharman, 1966) and its potential to assist conservation efforts was recognised at that time. Cross-fostering has previously been used successfully in potoroid species. Cross-fostering of northern bettong young (*Bettongia tropica*) to *Bettongia penicillata* females resulted in an up to four-fold increase in production of young in captivity (Smith, 1998).

Additional Gilbert's potoroos are required for the captive breeding program to expand the genetic variability within the population, replace aging animals as they become non-reproductive or die and to build up the numbers sufficiently to provide animals for translocation. Removal of adult animals, especially females, from the wild is highly undesirable because the known wild population numbers less than 20 individuals. In addition, natural conception rates in the captive colony have been so low that adding extra adult animals may not result in any increase in reproduction in captivity.

If successful, this procedure would have several benefits. It would (i) increase the genetic variability in the captive colony (as far as possible, given the limited variability in the wild population reported by Sinclair *et al.*, 2002), (ii) accelerate overall reproduction of young by the wild population by enabling a female to produce more than the estimated maximum of three young per year, and (iii) increase the reproductive potential of the captive breeding colony so that it could fulfil both of its original purposes of insurance and provision of animals for translocation.

Initial studies examining the feasibility of cross-fostering amongst potoroids are using young from *Potorous tridactylus* and trial *Potorous tridactylus*, *Bettongia penicillata* and *Bettongia lesueur* as potential surrogates. These trials are being conducted by Dr David Taggart on captive animals in Adelaide. Pouch young are removed from the teat of the donor female, taking care not to damage either the teat or the mouth of the young. The young is weighed and measured and then transferred to the pouch of a foster species female and allowed to reattach. Donor and foster mothers must have young that are close in size and the young of the surrogate mother is removed before the transfer. Removal of pouch young from the teat of the donor species results in cessation of the sucking stimulus which either reactivates the development of a quiescent blastocyst (if present) or causes the female to return to oestrus, mate and produce another young, thus increasing the reproductive rate. Growth rates, length of pouch life, time to weaning and time to independence of cross-fostered young will be compared with those in mother-reared young and the timing of fostering manipulated to

maximise success. Results of these trials will be used to recommend the most suitable surrogate species to receive young from Gilbert's potoroo.

The survival of potoroid pouch young after removal from the teat of their natural mothers, short-term isolation and reattachment to the teats of foster mothers will also be determined.

Responsibility:	University of Adelaide
Cost (first 3 years):	\$132600 in first year
Priority:	High
Completion date:	2003

Action 5.5.4 Develop a cross fostering protocol for Gilbert's potoroo pouch young from the wild and carry out a limited trial.

A decision will be made on the most suitable surrogate species for cross-fostering Gilbert's potoroo pouch young based on the results of trials conducted under Action 5.5.3. A detailed protocol will be established outlining the procedure to be followed when cross-fostering pouch young of this species from the wild to surrogate females.

Subject to appropriate approvals, a limited trial will be carried out. Up to four Gilbert's potoroo pouch young will be transferred from wild females at Two Peoples Bay and transferred to suitable surrogate females in Adelaide, where captive colonies of potential surrogate species are already established. The donor female would be trapped at intervals after the removal of the young to establish the time interval before the next birth, in order to refine the population model developed earlier (Action 5.2.1). Survival and growth of the cross-fostered young will be monitored. Further development of a cross-fostering program for Gilbert's potoroo will depend on the success of this trial.

Responsibility:	University of Adelaide, CALM
Cost (first 3 years):	\$14725 in first year
Priority:	High
Completion date:	2004

Action 5.5.5 Develop semen collection and evaluation protocols for Gilbert's potoroo.

Assisted reproduction techniques require synchronisation of semen collection with the detection of oestrus in the female. As no freeze/thaw protocols have yet been developed for any macropod species, artificial insemination (AI) must be done with freshly collected sperm. Semen will be collected by electro-ejaculation using previously developed methods (Taggart *et al.*, 1996, 1998). These methods will be developed in analogue species such as *Potorous tridactylus* before their application to Gilbert's potoroo.

Responsibility:	Perth Zoo
Cost (first 3 years):	\$5000 in first and second years
Priority:	High
Completion date:	2005

Action 5.5.6 Develop artificial insemination techniques for Gilbert's potoroo.

In order to optimise the chances of reproductive success artificial insemination must proceed when the female potoroo is in oestrus. Approaching oestrus will be detected by taking regular vaginal smears and observations of pouch condition or from progesterone levels in faeces. When approaching oestrus is detected, artificial insemination will proceed. The

ovaries will be examined for the presence of a large follicle by laparoscope and insemination will occur directly into the uterus with all the sperm collected from the male. Intra-uterine insemination has proved the most successful route with tammar wallabies and brushtail possums (Molinia *et al.*, 1998). These methods will be developed in analogue species such as *Potorous tridactylus* before their application to Gilbert's potoroo.

Responsibility:	University of WA, Perth Zoo
Cost (first 3 years):	\$238611 in second year, \$153984 in third year.
Priority:	High
Completion date:	2007

Action 5.5.7 Develop a draft Captive Management Strategy for Gilbert's potoroo.

Development and implementation of both cross-fostering techniques and artificial insemination require planning to ensure that sufficient animals are available in appropriate housing and that they are maintained in conditions that will maximise the chance of success of the technique(s). For example, implementation of artificial insemination techniques requires frequent handling of animals. To minimise stress to the animals, it is essential that only animals used to frequent handling are subjected to this procedure. This may mean that a number of young will need to be hand-reared to accustom them to the levels of handling required. A Captive Management strategy needs to be developed to address a range of issues such as the number and size of enclosures required to maintain the surrogate population for cross-fostering, husbandry requirements, planning for hand-rearing of young and so on.

Responsibility:	Captive Management Group, Recovery Team through CALM
Cost (first 3 years):	\$7100 in first year
Priority:	High
Completion date:	December 2003

Action 5.6: Enhance breeding capacity of Gilbert's potoroo

Action 5.6.1 Establish a large intensive or semi-wild colony of surrogate species near Albany.

If the cross-fostering trial to be conducted in Adelaide is successful, and if field studies indicate that the wild Gilbert's potoroo population can sustain further harvest of young, a colony of the selected surrogate species will be established near Albany. The colony will be established initially in unused pens in the Gilbert's potoroo breeding facility at Two Peoples Bay, then moved to another location when facilities are erected, on dedicated land acquired by purchase or agreement. The cross-fostering facility should provide both small enclosures for close observation and an extensive bushland area of several hectares in which the bulk of the surrogate population can be held, with supplementary feeding.

The surrogate colony should consist of at least 60 females and 15 males. Management of the colony will be necessary in order to maintain this sex ratio.

Responsibility:	CALM
Cost (first 3 years):	\$293800 in second year, \$63380 in third year.
Priority:	High
Completion date:	2005

Action 5.6.2 Implement techniques for cross-fostering from the wild in order to recruit Gilbert's potoroo pouch young from Mt Gardner populations into the captive breeding population or for translocation.

Based upon the success or failure of trials conducted under Action 5.5.4, pouch young will be cross-fostered directly from wild Gilbert's potoroo females on Mt Gardner to captive surrogate females. Cross-fostering from wild populations will be used to increase the reproductive rate of wild females on Mt Gardner and expand the size and genetic diversity of the captive colony. The rate at which pouch young can be safely transferred from the wild into captivity (if at all) will be determined by the Recovery Team and will be based on the status of the wild population (numbers known to be alive, age structure, sex ratio etc), the results of juvenile survival and recruitment studies conducted under Action 5.2.1, on progress in improved captive husbandry (Actions 5.4.4 & 5.4.5) and availability of sufficient housing (Actions 5.6.1).

Responsibility: CALM
Cost (first 3 years): \$14800 in second and third years.
Priority: High
Completion date: Ongoing

Action 5.6.3 Establish a large fenced area in natural habitat for acclimatisation of Gilbert's potoroos prior to reintroduction.

The current facilities at Two Peoples Bay and Perth Zoo are both too small to maintain a colony of sufficient size to provide animals for translocation. A new facility will therefore need to be established with the most likely scenario being a 50-100 ha predator proof enclosure in suitable habitat near Mt Manypeaks. This will allow animals to develop some skills in finding food and avoiding predators (the enclosure would probably be open to reptilian and avian predators but would be secure from feral mammalian predators) prior to release into a completely wild situation. This type of enclosure would also be preferable to a fully provisioned facility if husbandry difficulties have not been overcome. Construction of this enclosure will need to be commenced as soon as it is clear that the assisted reproduction techniques are proving successful and that sufficient young are likely to be produced to require such an enclosure.

Responsibility: CALM
Cost (first 3 years): \$180100 in third year only.
Priority: High
Completion date: 2006

Action 5.6.4 If appropriate, implement artificial insemination procedures using freshly collected semen to increase reproductive rates in the captive colony.

Based upon the success or failure of trials conducted under Action 5.5.5 and 5.5.6, a decision will be made on whether semen collection and artificial insemination procedures should be implemented to increase reproductive rates in the captive colony.

Responsibility: Perth Zoo
Cost (first 3 years): No cost in first three years.
Priority: High
Completion date: Ongoing, if successful.

Action 5.6.5 Using fresh and/or stored semen from both wild and captive males, combine artificial insemination and cross-fostering techniques to increase captive reproduction without the ongoing need to harvest pouch young from the wild.

If both artificial insemination and cross-fostering techniques prove to be successful and appropriate methods for increasing reproductive output in Gilbert's potoroo, these techniques will be applied in combination in at least some cases to increase the captive reproductive rate and limit harvest pressure on the wild population. In appropriate circumstances, young conceived in captivity either naturally and/or through artificial insemination will be removed and cross-fostered to surrogate mothers thus freeing the Gilbert's potoroo mother to reproduce again. The decision of whether to undertake this combination of techniques at all and, if so, when and which female(s) to use as targets will be made by the Captive Management group in consultation with the Recovery Team. Unless natural breeding rates are considerably improved, the number of young produced in captivity will continue to be insufficient to enable cross-fostering of captive born young to significantly improve reproductive success. The use of artificial insemination techniques to achieve conception coupled with the cross-fostering of young could resolve this problem without having to continue harvesting pouch young from the wild to maintain the captive colony.

Responsibility:	Perth Zoo, CALM
Cost (first 3 years):	No cost in first three years.
Priority:	Low
Completion date:	Ongoing, if successful.

Action 5.6.6 Development of a gene bank to retain genetic diversity in both captive and wild populations.

Every Gilbert's potoroo is an important component of the species genetic diversity and loss of any animal before it breeds leads to loss of genetic variability from the population. Small populations whether wild or captive are particularly at risk and the loss of genetic variability often leads to extinction of the population. Semen will be collected by electro-ejaculation as described by Taggart *et al.* (1996, 1998). Semen freeze/thawing techniques using various diluents and cryoprotectants will be developed in analogue species such as *Potorous tridactylus* before being applied to Gilbert's potoroo. Should ovarian tissue become available it will also be stored frozen for possible future in vitro culture and transfer to surrogate females. Freeze/thaw protocols for ovarian tissue will be developed in analogue species such as *Potorous tridactylus* before being applied to Gilbert's potoroo.

Responsibility:	Perth Zoo
Cost (first 3 years):	\$10000 per year in second and third years.
Priority:	Low
Completion date:	2007

Action 5.6.7 Develop a Captive Management Plan for Gilbert's potoroo.

A draft Captive Management plan following ARAZPA guidelines (Courtenay, 1998b) was written before animals were transferred to Perth Zoo to investigate artificial insemination techniques and before the cross-fostering trials were under way. It therefore only covers natural breeding at Two Peoples Bay. If the assisted reproduction methods and cross-fostering prove successful, the plan will need to be rewritten to include the assisted reproduction methods and the fact that the colony may be divided between several institutions.

Responsibility:	Recovery Team through CALM
Cost (first 3 years):	No cost in first three years.
Priority:	Low
Completion date:	2007

Action 5.7: Extend the range of Gilbert's potoroo through translocation of animals to suitable habitat outside Two Peoples Bay.

Action 5.7.1 Plan a reintroduction strategy for captive-bred Gilbert's potoroos.

A Reintroduction Working Group will be established including appropriate members of the Recovery Team to plan and implement reintroduction of Gilbert's potoroos to the wild. The Reintroduction Working group will produce a reintroduction plan that will set targets for production of young using available techniques and make recommendations on translocation site(s), predator control, composition of founder groups, timing, season and method of release and monitoring protocols.

The use of Mount Gardner as a source of animals for translocation may also need to be considered. Reintroduction into suitable habitat outside Two Peoples Bay is considered to be the major strategy for conservation of this species. Wild to wild translocation of Gilbert's potoroo might be considered under the following circumstances:

- (i) The cross-fostering and artificial insemination techniques fail to produce enough animals for translocation.
- (ii) It is shown that there is high wastage of juveniles on Mount Gardner due to a lack of unoccupied habitat and removal of some individuals would not affect the population.
- (iii) The total population increases through colonisation of areas surrounding Mount Gardner and population models indicate that there are enough individuals to sustain some harvest for translocation.
- (iv) Threats to the Mount Gardner population (for example from fire, *Phytophthora* etc.) increase to an unacceptable level so that removal of some animals is required to ensure the species' survival.

Responsibility:	Recovery Team through CALM
Cost (first 3 years):	\$8200
Priority:	High
Completion date:	2004

Action 5.7.2 Select and prepare translocation sites (baiting, fire management etc...).

Possible sites for translocation need to be identified and assessed as soon as the reintroduction plan (Action 5.7.1) is completed. Any actions required for preparation of the site (such as increasing frequency of baiting, developing a fire management plan etc...) should be identified and implemented in accordance with the reintroduction plan. Assessment of translocation sites may include the use of a trial translocation of two to three pioneer individuals. Such a trial could occur as early as 2004 if funds are available.

Responsibility:	CALM
Cost (first 3 years):	\$32250 in second and third years
Priority:	High
Completion date:	2006

Action 5.7.3 Undertake a translocation according to the reintroduction strategy.

When sufficient animals are available and the reintroduction site is prepared, undertake a translocation according to the guidelines in the reintroduction strategy.

Responsibility: CALM
Cost (first 3 years): No cost in first three years.
Priority: High
Completion date: 2007

Action 5.7.4 Review the translocation and develop improved protocols for future attempts if required.

After a translocation has been carried out and results of monitoring are available, the procedures and outcomes will be reviewed. The review will examine all components of the translocation including release protocols, group composition, monitoring protocols and outcomes. Depending on the outcome of the review, protocols may need revision for subsequent translocation attempts.

Responsibility: Recovery Team through CALM
Cost (first 3 years): No cost in first three years.
Priority: High
Completion date: 2008

Action 5.8: Secure ongoing funding for the implementation of the Recovery Actions.

Action 5.8.1 Undertake efforts to source additional funding to support the Recovery Program.

The cross-fostering trials are currently funded for three years beginning in 2001 through an ARC SPIRT Grant to Dr David Taggart and Associate Professor Bill Breed of Adelaide University. The initial artificial insemination research at Perth Zoo was funded until June 2003 through the Marsupial CRC. Both programs will require ongoing funding beyond these grants and additional funding will be required, for example, for the establishment of facilities for the surrogate colony (Action 5.6.1), and for the construction of the acclimatisation enclosure for animals prior to translocation (see Action 5.6.3). Funding is also required for the survey and research aspects of the field program and for the ongoing maintenance of the captive colony at Two Peoples Bay. Given the difficulty that the Gilbert's potoroo program has experienced in securing sufficient funding, more proactive attempts to seek funding for capital works, staffing and other research expenses are clearly required. All Recovery Team personnel should be responsible for pursuing opportunities for sponsorship, grant funding and corporate monies in order to assist the expansion of all aspects of the Recovery Program. Any possible funding applications or corporate sponsorships will be discussed in the first instance with the Chair of the Recovery Team and CALM's Sponsorship Co-ordinator, before development of a formal application. A sponsorship package will be produced by the Recovery Team.

Responsibility: Recovery Team through CALM
Cost (first 3 years): \$2550 per year

Priority: High
Completion date: Ongoing

Action 5.8.2 Encourage community groups to undertake fundraising and seek community grants to carry out appropriate actions e.g. hair arching and hair analysis.

Because of the highly technical nature of much of the work, the extremely low numbers of animals and the fragility of the habitat, opportunities for active community involvement in the implementation of the Recovery Actions are very limited. Community groups are however, assisting in actions involving raising community awareness, seeking donations and in carrying out some practical work (for example, hair arch surveys and analysis). Interested groups will continue to be encouraged to apply for community conservation grants for appropriate small projects and ongoing assistance and training is being provided to enable the group members to design and implement effective projects.

Responsibility: Recovery Team through CALM
Cost (first 3 years): Staff time only
Priority: High
Completion date: Ongoing

Action 5.8.3 Investigate collaborative research programs with universities and other organisations.

The Recovery Team should actively seek the involvement of other research institutions and universities in undertaking the research components of the Recovery Plan. Academics and research scientists at such institutions can source funding for research in their area of expertise, or encourage post-graduate or Honours students to undertake projects that address aspects of the Recovery Actions.

One problem with this type of collaborative research is, however, the issue of ownership of the data. Because of the critically endangered status of the Gilbert's potoroo and the fragility of the habitat it is essential to limit research projects to those that contribute directly to one or more of the Recovery Actions. All data collected in the process of carrying out such research must be made available to the Recovery Team on request to inform management decisions. To protect the rights of the researcher and their funding source, no data obtained in this way can be published by the Recovery Team without the written consent of the author.

Responsibility: Recovery Team through CALM
Cost (first 3 years): \$2550 per year
Priority: High
Completion date: Ongoing

6. TOOLS TO ASSIST IMPLEMENTATION

6.1 Costs of the recovery program

The recovery program is currently supported by the input of staff and resources from CALM, Perth Zoo, the Marsupial CRC, Adelaide University, the Royal Zoological Society of South Australia, Cleland Wildlife Park, the Natural Heritage Trust and the Australian Research Council. Small grants have been received from World Wide Fund for Nature Australia/Threatened Species Network, Bankwest *Landscape* Conservation Visacard and

National Geographic. Potential sources of additional funding include the WA Lotteries Commission, private sponsors and large corporate sponsors.

6.2 Implementation Table – Gilbert's Potoroo Recovery Plan

Action No	Action	Cost, three years	Responsibility	Completion date
5.1	Protect the existing wild population and habitat			
5.1.1	Fox Baiting	\$30 600	CALM	Ongoing
5.1.2	Cat control and monitoring	\$26 820	CALM	Ongoing
5.1.3	Fire management	\$12 000	CALM	Ongoing
5.1.4	Dieback hygiene	\$11 865	CALM	Ongoing
5.1.5	Monitor wild population	\$50 705	CALM	Ongoing
5.1.6	Community education	\$21 800	Recovery Team through CALM	Ongoing
5.2	Increase understanding of ecology and population biology of Gilbert's potoroo to underpin management strategies			
5.2.1	Population biology, especially fate of juveniles	\$34 500	CALM	Ongoing
5.2.2	Ecology including diet, habitat requirements and social organization	\$45 800	CALM	2004
5.2.3	Effect of <i>Phytophthora</i> on habitat	\$10 780	CALM, Universities	2007
5.3	Search for new populations of Gilbert's potoroo outside Two Peoples Bay			
5.3.1	Conduct surveys of suitable habitat	\$56 150	CALM	Ongoing
5.3.2	Encourage community groups to search	\$6720	Recovery Team through CALM, Community Groups	Ongoing
5.4	Establish and maintain a captive breeding colony of Gilbert's potoroo			
5.4.1	Establish one or more captive colonies	\$185 240	CALM, Perth Zoo	Ongoing
5.4.2	Captive management group	\$7680	Recovery Team through CALM	Ongoing
5.4.3	Carry out nutritional analysis of truffles and redesign captive diet	\$10 650	CALM	2004
5.4.4	Continue to research, improve and develop husbandry	\$9000	CALM, Perth Zoo	2007
5.4.5	Investigate and manage veterinary issues in captives	\$18 150	CALM, Perth Zoo	Ongoing

5.4.6	Investigate inheritance of oxalosis and develop DNA markers	\$12 050	CALM, Universities	2004
5.4.7	Revise husbandry manual	\$2050	Recovery Team through CALM	July 2004
5.4.8	Maintain a studbook for captives	\$2925	CALM	Ongoing
5.5	Develop techniques to enhance the reproductive potential of Gilbert's potoroo			
5.5.1	Gather basic information on reproductive biology, growth and development of GP	No extra cost	CALM	Ongoing
5.5.2	Trial and review natural reproduction options	No extra cost	CALM	Ongoing
5.5.3	Develop cross-fostering techniques between potoroid species	\$132 600	University of Adelaide	2003
5.5.4	Develop a cross-fostering protocol for GP and carry out a limited trial	\$14 725	University of Adelaide, CALM	2004
5.5.5	Develop semen collection and evaluation protocols	\$10 000	Perth Zoo	2004
5.5.6	Develop artificial insemination	\$392 595	University of WA, Perth Zoo	2007
5.5.7	Develop a draft Captive Management Strategy for Gilbert's potoroo.	\$7100	Captive Management Group, Recovery Team through CALM	2003
5.6	Enhance the breeding capacity of Gilbert's potoroo			
5.6.1	Establish a large intensive or semi-wild colony of surrogate species near Albany	\$356 460	CALM	2005
5.6.2	Implement techniques for cross-fostering from the wild to obtain animals for captive population or translocation	\$29 600	CALM	Ongoing
5.6.3	Establish a large fenced area in suitable habitat for acclimatisation of GPs	\$180 100	CALM	2006
5.6.4	Implement artificial insemination	No cost in first three years	Perth Zoo	Ongoing, if successful
5.6.5	Using fresh/stored semen combine artificial insemination and cross-fostering techniques to increase captive reproduction	No cost in first three years	Perth Zoo, CALM	Ongoing, if successful
5.6.6	Develop a gene bank to retain genetic diversity (frozen semen)	\$20 000	Perth Zoo	2008
5.6.7	Revise draft captive management plan	No cost in first three years	Recovery Team through CALM	2007
5.7	Extend the range of Gilbert's potoroo through translocation of animals to suitable habitat outside			

	Two Peoples Bay.			
5.7.1	Plan a reintroduction strategy for captive bred or cross-fostered GPs	\$8200	Recovery Team through CALM	2004
5.7.2	Select and prepare translocation site	\$64500	CALM	2006
5.7.3	Undertake a translocation	No cost in first three years	CALM	2007
5.7.4	Review the translocation and develop improved protocols	No cost in first three years	Recovery Team through CALM	2008
5.8	Secure ongoing funding for the implementation of the Recovery Actions			
5.8.1	Undertake efforts to source additional funding	\$7650	Recovery Team through CALM	Ongoing
5.8.2	Encourage community groups to undertake fundraising	\$6150	Recovery Team through CALM	Ongoing
5.8.3	Investigate collaborative research programs	\$6150	Recovery Team through CALM	Ongoing
	TOTAL COST – 3 YEARS	\$1792 595		

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