WESTERN AUSTRALIAN WILDLIFE MANAGEMENT PROGRAM NO. XX

GILBERT'S POTOROO RECOVERY PLAN

1998-2007

by

Jackie Courtenay[1], Tony Start[2] and Andrew A. Burbidge[2]

for the Gilbert's Potoroo Recovery Team

[1] **c/- Department of Conservation and Land Management**
120 Albany Highway, Albany WA 6330

[2] **Department of Conservation and Land Management**
Western Australian Wildlife Research Centre
PO Box 51, Wanneroo, WA 6065

Department of Conservation and Land Management
PO Box 104,
Como
Western Australia 6152

FOREWORD

The Western Australian Department of Conservation and Land Management (CALM) publishes Wildlife Management Programs to provide detailed information and management actions for the conservation of threatened communities or harvested species of flora and fauna.

Recovery Plans are Wildlife Management Programs that delineate, justify and schedule management actions necessary to support the recovery of an endangered or vulnerable species or ecological community. The attainment of objectives and the provision of funds 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 positions of any individuals or agencies represented on the Recovery Team. This Recovery Plan has been approved by the Executive Director, Department of Conservation and Land Management, the National Parks and Nature Conservation Authority and the Minister for the Environment.

Approved Recovery Plans are subject to modification to take account of new findings, changes in species' status and completion of recovery actions. Where Environment Australia supports the implementation of Recovery Plans, the results of all recovery actions are presented in annual reports to the Threatened Species and Communities Unit of Environment Australia.

An Interim Recovery Plan (IRP) was first prepared for Gilbert's Potoroo, in 1995 (Start and Burbidge 1995) and submitted to the Australian Nature Conservation Agency (now Environment Australia) for funding under the Endangered Species Program to supplement resources provided by CALM. Environment Australia provided bridging funds from mid-1995 and funded a three-year program, 1996-1998. A Recovery Team was established to oversee the implementation of the IRP. It first met in 1995. The Recovery Team reviewed the IRP in 1997 and decided that a full recovery plan could now be written. This Recovery Plan was prepared in 1997/98 and information in it was accurate at 1 February 1998.

CONTENTS

SUMMARY

CURRENT CONSERVATION STATUS.
Fauna that is likely to become extinct or is rare (*Western Australian Wildlife Conservation Act 1950*); Endangered (*Commonwealth Endangered Species Protection Act 1992*); Critically Endangered (*The 1996 Action Plan for Australian Marsupials and Monotremes*). Known only from a single population on Mt Gardner, in Two Peoples Bay Nature Reserve, near Albany, Western Australia. Meets IUCN (1994) Red List Category 'Critically Endangered' under Criteria C2b and D.

HABITAT REQUIREMENTS AND LIMITING FACTORS. On Mt Gardner, known habitat is thick heath, often with open patches. In 1840 Gilbert reported it from other habitats, including spearwood thickets beside streams, and noted it was associated with quokkas. Apparently always restricted to the wettest areas of coastal south-western Australia. Limiting factors may include habitat availability, feral predators, fire regimes and plant diseases. These may interact. Population fragmentation and an inability to naturally re-stock may have caused the cumulative effects of local extinctions to be near-total extinction. Habitat requirements thus include sufficient patchiness to ensure that refugia remain despite disturbances such as fire and the consequent removal of cover.

OBJECTIVES.

1. Minimise the risk of catastrophic loss of the single known wild population by habitat management and maintenance of a genetically viable, captive breeding colony.
2. Determine the present range and viability of wild populations.
3. Increase the size, number and viability of wild populations through habitat management, control of threatening processes, captive breeding and translocation.
4. Ensure that captive and wild populations maintain at least their present levels of genetic diversity.
5. Using internationally accepted criteria, down list the species from Critically Endangered to Endangered (IUCN 1994) within ten years.

CRITERIA FOR SUCCESS

1. A self-sustaining, captive population of about 30 individuals producing surplus animals for translocation.
2. Hygiene, husbandry and genetic integrity of the captive colony is managed in accordance with a comprehensive, written Working Plan to be prepared during 1998.
3. The distribution and resource requirements of Gilbert's Potoroo at Two Peoples Bay NR are documented.
4. A quantitative monitoring program records changes in population density and the area of occupancy of potoroos at Two Peoples Bay Nature Reserve.
5. Population density of potoroos on Mt Gardner is maintained or increased and the area of occupancy expands to sites beyond Mt. Gardner.
6. The occurrence of Gilbert's Potoroo beyond Two Peoples Bay NR, particularly on Mt Manypeaks, is determined.
7. At least two new self-sustaining populations are established by translocation of captive-bred stock.
8. By 2007 Gilbert's Potoroo is down-listed to endangered defined by IUCN 1994 Red List criteria.

RECOVERY ACTIONS

1. Appoint a scientist and a technical officer to implement the Recovery Plan
2. Develop and maintain a breeding colony of at least 30 potoroos plus surplus animals pending translocation.
3. Write and implement a Working Plan to oversee hygiene, husbandry and genetic integrity of the captive colony.
4. Investigate and document the distribution and resource requirements of Gilbert's Potoroo at Two Peoples Bay NR.
5. Establish a quantitative monitoring program to record changes in population density and area of occupancy of wild potoroo populations.
6. Abate processes that may threaten or limit area of occupancy and/or population density of potoroos.
7. Search for potoroos outside Two Peoples Bay NR.
8. Establish new populations by translocation.
9. Review the conservation status of Gilbert's Potoroo according to IUCN criteria in 2007
10. Review the Recovery Plan

ESTIMATED COST OF RECOVERY

Item	1999		2000		2001	
	CALM	**EA**	**CALM**	**EA**	**CALM**	**EA**
Action 1	61 300	54 700	62 800	56 200	64 300	57 700
Action 2	2 000	12 000	2 000	9 500	2 000	10 000
Action 4	4 900	3 900	0	1 000	0	1 000
Action 5	0	500	0	500	0	500
Action 6	16 000	0	16 000	0	16 000	0
Action 7	0	10 000	0	10 000	0	10 000
Action 8	0	0	0	0	0	5 500
Action 10	0	0	0	0	0	1 000
Participant total	82 200	81 100	80 800	77 200	82 300	85 700
Action Total	163 300		158 000		168 000	

BIODIVERSITY BENEFITS. 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 NR is also home to four threatened bird species including Noisy Scrub-birds (which also survived only on Mt Gardner) and the Reserve contains a rich flora that includes 4 threatened species. Management for potoroos will be compatible with the other conservation values and all species will benefit. Indeed, it is possible that management for other conservation values enabled Gilbert's Potoroo to survive there.

1. INTRODUCTION

1.1 Description of Species

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. Its body, but not the tapered tail, is densely furred. Its eyes appear to look obliquely upward. It has typically macropodoid hind feet and long, curved claws on its front feet that it uses to dig for food.

Gould (1841) described the species 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 but Ride (1970), Calaby and Richardson (1988) and Johnston (1995) considered it fully synonymous with *P. t. tridactylus* of south eastern mainland Australia.

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, eastern Australian taxa, *P. longipes,* and *P. tridactylus,* by the same order of magnitude as they differ from each other. Sinclair and Westerman 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).

Cranial morphology supports this conclusion (Courtenay[1], unpublished data). 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.

1.2 Past Distribution

John Gilbert collected the first specimens at "King George's Sound" in 1840. George Masters obtained it in 1866 and 1869 between King George Sound and the Salt (Pallinup) River and William Webb took one 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 (Fisher[2], personal communication). Sub-fossil specimens have been collected at various sites between Albany and Margaret River, including several caves on the Leeuwin-Naturaliste Ridge. Specimens from Devil's Lair have been dated to 12 175 ± 225 BP (Dortch and Merrilees 1971).

It appears from early records that Gilbert's Potoroo has always been restricted to the high rainfall areas of the South West corner of Western Australia, but apparently it was locally abundant in those areas. This is suggested by the ease with which early collectors obtained specimens and John Gilbert's notes written for John Gould (1863). He recorded that "immense numbers" could be captured with quokkas by Aborigines in a single afternoon.

1.3 Present Distribution

Gilbert's Potoroo was thought to be extinct because no live animals were recorded after the 1870s. However, in December 1994 five were trapped by Elizabeth Sinclair and Adrian Wayne (Sinclair *et al.* 1996) on Mt Gardner in Two Peoples Bay Nature Reserve near Albany on the south coast of Western Australia. It is still only known from Mt Gardner where animals have been trapped at seven sites. Hair tube surveys at nearby locations have produced single hairs on two occasions from one site on Mt

[1] Dr. Jackie Courtenay, Department of Conservation and Land Management.
[2] Dr Clemency Fisher, Curator of Birds and Mammals, Liverpool Museum.

Manypeaks. Hairs from Gilbert's Potoroos and Quokkas are easily separated from all other sympatric species but they can be difficult to distinguish from one another. The presence of Gilbert's Potoroo on Mt Manypeaks needs confirmation.

1.4 Habitat

John Gilbert described the habitat of Potoroos as "the dense thickets and rank vegetation bordering swamps and running streams" and noted that they were the "constant companion" of Quokkas, *Setonix brachyurus* (Gould 1863 and Gilbert's manuscript notes written for Gould, which have survived).

The habitats in which the species has so far been trapped on Mt. Gardner are uplands of low, dense heath containing many small patches of more or less open ground. The vegetation is often dominated by *Melaleuca striata*. Accumulations of *Allocasuarina fraseriana* needles are sometimes used for shelter. Vetten (1996) used spools of fine nylon thread attached to the animals to obtain more detailed information on habitat use by one group of Gilbert's Potoroos. She found that the animals did not always stay in the thick vegetation. They spent a considerable portion of each night foraging in the open patches between *Melaleuca* clumps or in open ground under patches of *Banksia* spp., *Eucalyptus marginata* or *Eucalyptus calophylla.*

1.5 Life History and Ecology

The reproductive biology of Gilbert's Potoroo is little known compared to that for *P. tridactylus* and *P. longipes*. However, it is already apparent that Gilbert's Potoroo differs from the others in some significant respects.

P. tridactylus has the longest reported gestation among marsupials. It is 38 days, or 29 days for an embryo that has been in diapause (Shaw and Rose 1979). Female *P. tridactylus* become sexually mature at about twelve months and appear to breed throughout life. In captivity they have bred for seven to ten years (Ullman and Brown 1983). Young are apparently born throughout the year in the wild but with birth peaks in early spring and late summer (Johnston 1995). However, Seebeck (1992) reports that captive Long-footed Potoroos only breed in the second half of the year, and no young have been born in captivity earlier than June. Six Gilbert's Potoroos have been conceived and born in captivity in October (1) December (3) and April (2). They include one known to have been a diapause embryo. Two more young known to have been conceived young have been born in captivity Wild caught females have been carrying young at all times of year although young born in mid-winter may have been diapause embryos from summer matings. Birth peaks apparently occur in summer and autumn with 13 of the 18 known young born between December and May.

Age at sexual maturity is not yet known for Gilbert's Potoroo. However, one male of known age sired his first young at about 14 months and a female aged about 18 months (based on tooth eruption) was carrying a pouch young while an enlarged nipple indicated that another had recently left the pouch. Two females conceived in captivity had reached near adult weight at about 9 months at which time one of them was housed with a male. At 26 months she had still not produced a young. The reason is unknown but factors such as diet, season and social incompatibility, rather than immaturity, may have been the cause. Pairings of certain adult animals have been infertile, even though both animals have produced young with other partners. This suggests that Gilbert's Potoroo may exhibit a monogamous breeding system similar to that postulated for *Potorous longipes* (Serena *et al.* 1996). 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. Nevertheless, management of pairings will be critical to breeding success and genetic management of the colony.

There are apparently no published records of reproductive senescence in potoroids, although an unpublished report on Potoroo testicular biopsies suggested that testicular senescence was a possible factor in the testicular regression and apparent infertility of captive *P. tridactylus* males (Temple-Smith and Taggart 1994). While testicular senescence is unlikely to be a problem in the *P. gilbertii* colony for at least the next few years (3 of the 4 males entered the colony as juveniles), reproductive senescence of at least one of the adult females may be a possibility. This female appears, from extreme tooth wear, eye cataracts, and greying fur, to be an old individual, and has not conceived while in captivity despite being

housed with various males for periods of several months.

There is some equivocal evidence that the gestation period following embryonic diapause appears to be considerably shorter than observed in *P. tridactylus*. This needs to be clarified. Length of pouch life is also unclear. Two young born in April remained in the pouch for four months, a similar period to that observed for *P. tridactylus*. In contrast, two young apparently born in late December exited the pouch in early April, a period of about 3.5 months. However, it is possible that their estimated birth dates (based on their estimated size in early January) were inaccurate and that they were born in early December. More regular handling of the captive animals since September 1996 and the use of Video cameras for monitoring, will help to more accurately estimate gestation periods, birth dates and duration of pouch life.

While no young were conceived in the colony until the end of the first year (1995), it is likely that this was due to the immaturity of most of the males, the stresses involved in adapting to captive life and several moves as new cages were built (two females lost young that were either in the pouch or in diapause at the time of capture). Since late 1995, six young have been conceived in captivity and five have been raised to pouch exit.

In captivity, young are first observed out of the pouch at about 150 g body weight and achieve permanent pouch exit about five days to a week later, at about 190 g. Over the next few months they gain, on average, 6 g per day. Young at pouch exit have the deciduous upper and lower central incisors, the deciduous premolar and M^1. The second deciduous incisor and M^2 are erupting. The deciduous canine begins eruption just prior to weaning. Preliminary growth curves following pouch exit, based on six individuals (including two that were wild born but exited the pouch in captivity) are available.

Average life expectancy for Gilbert's Potoroo is unknown. In a long term study of *P. tridactylus* in Tasmania, one individual male was known to survive in the wild for 7+ years although this is undoubtedly close to the maximum for the species and average longevity is likely to be considerably shorter (Guiler and Kitchener 1967). Seebeck (1982) reports that most *P. tridactylus* in captivity survive for 4-5 years, although individuals have lived for up to 9 years. Average life expectancies for Gilbert's Potoroos are probably of a similar range. Ullman and Brown (1983) note that one captive male *P. tridactylus* in a British colony began developing cataracts at about 6 years. One female in the captive colony is developing cataracts, and two wild males exhibit a similar degree of tooth wear to the captive female, suggesting that they also may be of similar age.

Periods of high mortality risk in the life of Gilbert's Potoroo are not known. Early experiences with the captive colony suggested that mortality in early pouch life may be high. Seebeck (1982) also found that early pouch life was a time of high mortality risk for *P. tridactylus*. He reported that, over three years, 17 captive females produced 65 young, of which 49 (76%) survived beyond one month. One of his females produced nine young of which five were raised to maturity. However, more recently, survival of pouch young in the Gilbert's Potoroo captive colony has been high; lack of conception is a more limiting factor. The early losses may have been due to factors such as the stress of adapting to captivity, moving to new enclosures, etc.

Gilbert's Potoroos can be divided into broad age categories on the basis of tooth eruption (in younger animals) and tooth wear (in older animals). While tooth wear patterns are likely to differ between the wild and captive animals owing to differences in diet and the amount of grit ingested with the food, the wear patterns can provide relative ages within each group. Tooth eruption sequences are likely to be relatively fixed for the species, so young animals in both the wild and captivity can be accurately aged.

Little is known of the social behaviour of wild Gilbert's Potoroo. Johnston (1995:302) notes that Long-nosed Potoroos are "solitary and sedentary" but also that "trapping records indicate that individuals tend to aggregate in small groups". The limited trapping and spooling studies of Gilbert's Potoroos, indicate that several adult males and females occupy at least partially overlapping ranges and that several males and females are using the same areas for day shelters (Vetten 1996). However, variability in the success of pairings within the captive colony, suggests that Gilbert's Potoroo may be monogamous. This topic

needs further study.

There is limited information on the home ranges of Gilbert's Potoroos. Radio tracking has shown that they will travel up to a kilometre from their day-time shelters while foraging and that they tend to return to the same area each morning, although they do not necessarily sleep in the same nest each day. Radio tracking has been carried out sparingly because prolonged wearing of the collars has caused injury to the skin and there is some concern that collared animals could not be re-captured soon enough to remove collars before they cause injury. Alternative collar materials and design are being investigated.

The scats of wild caught animals consist mostly of mycorrhizal fungal spores. This is consistent with the diets of other potoroos (eg. Tory *et al.* 1997). Gilbert's Potoroos have powerful front feet, armed with long claws that are well suited to digging. In captivity they dig conical burrows in the natural soil that constitutes the "floors" of the captive colony's cages and on Mt Gardner there are numerous conical diggings that may have been made by potoroos. However, it is not possible to distinguish them from the very similar diggings of Bandicoots (*Isoodon obesulus*) which are common on the mountain. Almost nothing is known of the species that compose the mycorrhizal flora of Two Peoples Bay, their fruiting phenology, host associations or their availability and palatability to potoroos. However it is of concern that various fungal pathogens cause diseases in the vascular flora of the reserve. They include *Phytophthora cinnamomi* which causes dieback in many species and which can drastically alter the floristic and structural composition of the vegetation. Its consequent impact on mycorrhizal fungi could be a threat to the food supply for potoroos.

1.6 Reasons for Listing

Gilbert's Potoroo is only known from one very small population. About 20 individuals are known to be alive, including 13 in captivity. While the wild population is almost certainly more than seven animals, the species extent of occurrence and area of occupation is limited to one mountain occupying about 1800 ha (some of which may be unsuitable habitat) in a Nature Reserve. Using the IUCN (1994) criteria, it is "Critically Endangered" under criteria C2b and D.

Its current conservation status is listed as:

- Fauna that is likely to become extinct or is rare (*Western Australian Wildlife Conservation Act 1950*)
- Endangered (*Commonwealth Endangered Species Protection Act 1992*)
- Critically Endangered (*The 1996 Action Plan for Australian Marsupials and Monotremes*).
- Critically Endangered (*The 1996 IUCN List of Threatened Animals*)

1.7 Existing Conservation Measures

The area known to be occupied by Gilbert's Potoroos is in part of a Class 'A' Nature Reserve vested in the Western Australian National Parks and Nature Conservation Authority and managed on its behalf by the Department of Conservation and Land Management. The site is in an area zoned "Special Conservation" in a Management Plan (Orr *et al.* 1995). An Interim Recovery Plan was prepared for the species immediately after its rediscovery (Start and Burbidge 1995). The Department of Conservation and Land Management are managing the species with financial support from Environment Australia. Edith Cowan University contributed significant support to March 1998 and the World Wide Fund for Nature, Australia has funded two activities in 1998.

1.7.1 Habitat Management

(a) Fire Management

Wild Gilbert's Potoroos have been trapped in dense, long unburnt vegetation that is highly flammable and vulnerable to wildfire. Fire exclusion is a 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 wild population through a catastrophic fire event.

Two strategies provide the basis for fire management at Two Peoples Bay: Fire exclusion and fuel reduction. The fire exclusion policy excludes prescribed fire from most of the reserve. However there is provision for carefully managed, prescribed burning for habitat management if relevant Recovery Teams deem it necessary. Fuel reduction involves strategically placed low fuel areas obtained by prescribed

burning, slashing, scrub rolling and/or other methods (Orr *et al.* 1995). There are carefully prepared plans by which wild fire will be suppressed.

(b) Dieback disease caused by *Phytophthora cinnamomi* on Mt. Gardner
Potoroos have usually been found in areas of the Reserve that are free of dieback infection. Dieback disease can cause considerable changes to the floristic composition and structure of the habitat. Gilbert's Potoroo feeds primarily on hypogeal fungi, many of which are mycorrhizal. Dieback infection could be a major threat to the continued survival of the Potoroo by altering vegetation structure or eliminating species which are either food sources in themselves or hosts to the mycorrhizal fungi on which they feed. Dieback surveys have been conducted in most areas of known Potoroo populations on Mt. Gardner and strict dieback hygiene practices are adhered to. Dieback mapping is continuing.

(c) Feral predator control using 1080 baits
Aerial baiting of Two Peoples Bay Nature Reserve using dried meat baits impregnated with 1080 is carried out four times a year. Egg baits are also buried along tracks in Two Peoples Bay Nature Reserve during the winter and are replaced regularly, especially if signs of a fox are noticed. No baits are yet available to control feral cats. Feral cats observed in the Reserve are either trapped or shot. However, CALM is working on the development of cat control methods and they will be applied when they are effective. The impact of feral cats is unknown but one wild potoroo carcass had features consistent of a feral cat kill.

1.7.2 Captive Breeding

The captive colony was established at Two Peoples Bay in December 1994 when four animals trapped by Sinclair *et al.* (1966) were brought into captivity. The founders were two adult females (both carrying pouch young), an adult male and a sub-adult male. They all came from Hakea Gully. In January 1995, the sub-adult male was released and replaced with a juvenile male from Firebreak Valley. In May 1995, a female with her male young at heel from Robinson's Valley was added to the colony and, in April 1996, another female with a female pouch young from Firebreak Valley were included. The founding stock thus includes animals from sites throughout the species' currently known range. Animals are fed on a diet of vegetables, mushrooms and nuts, which is based on the diet used to sustain the captive colony of *Potorous longipes* at Healesville Sanctuary (Merril Halley, personal communication).

The colony was established at Two Peoples Bay to reduce risks from long distance transport, changes in climate or exposure to unfamiliar pathogens, and to allow the wild and captive populations to be co-managed. Animals were housed in cages built for Noisy Scrub-birds until eight purpose-designed cages were constructed. Each 3 x 10 m cage is built around natural vegetation with a natural soil floor. Food, water and nesting material are located in a 3 x 3 m area adjacent to the door and under cover. The remainder of the cage is open to the elements. Removable doors between the cages enable animals to occupy two or more adjacent cages at the manager's discretion and solid panels close to ground level prevents visual contact between separated neighbours where it may result in conflict, stress and injury.

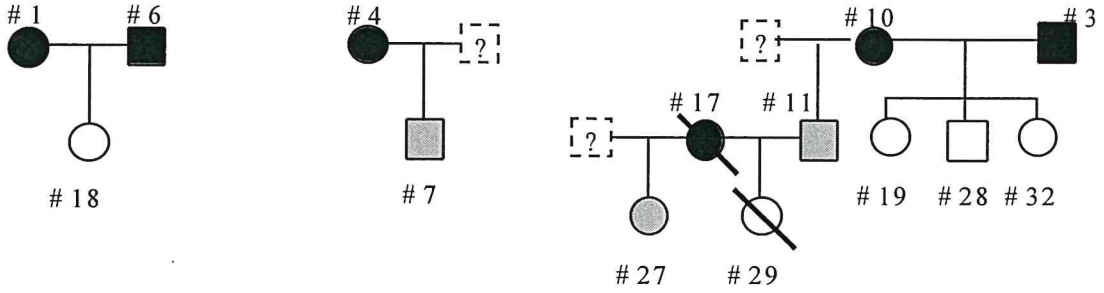
In the first 6 months of captivity, three pouch young were lost soon after their mothers were brought into captivity or when the mother was moved to the new enclosures. However, since then, one female with pouch young has been brought into captivity and she successfully raised her young to independence. Altogether eight young have been raised to permanent pouch exit in the colony.

The pedigree of the population is currently known (Figure 1) except;
- the paternity of three young who came into the colony from the wild with their mothers
- the interrelationships of the founders.

DNA analyses are currently being carried out in an attempt to determine the degree of relationship between all individuals in the colony.

Figure 1: Status and known relationships of individuals in the captive colony of Gilbert's Potoroo. Key: Circles = Female, Squares = Male, Dotted square with ? = unknown father of wild born young, Black = wild caught animal (unknown parentage), Grey = wild born animal (one parent known), White = captive

born animal (both parents known), Line through = animal deceased, # = unique number allocated to each (captive or wild) animal.



1.7.3 Ecological Research

Research has focused on two areas: the home range and habitat requirements of the known populations, and searching for more populations.

Two males and one female were fitted with radio collars and tracked in the vicinity of Firebreak Valley and Robinson's Valley. The female apparently confined activity to the Firebreak Valley area but the males moved between Firebreak Valley, Upper Robinson's Gully and Webster's Gully. However the males were tracked immediately after an adult female from the same area was moved into the captive colony. Their movement patterns may not be representative of normal foraging behaviour. No radio tracking has been done on the more stable East Firebreak population because the radio collars were causing severe chafing. Alternative collar designs and glue on transmitters are being trialed in the captive colony, and radio tracking of the wild population will recommence when a suitable collar design is developed.

A more detailed habitat-use study examined movements of six potoroos in Firebreak Valley with spool-and-line tracking techniques. Habitat was scored as a function of cover type (Vetten 1996). Fourteen thread trails were obtained. All except one indicated selective choice of habitat because cover types were used in different proportions to their presence in the habitat. Ten of the animals preferred open or semi-open country while four preferred dense cover. Animals that provided more than one trail were consistent in their choice of cover type. Foraging (indicated by concentrated areas of spool line and associated diggings) tended to be in the open areas. The use of open areas by Gilbert's Potoroos cannot be explained by transitory movement between denser patches because, on many occasions, the animals appeared to be avoiding the denser areas and concentrating their movement, especially their foraging, within the open patches.

These results contrast with Gilbert's notes (Gould 1863) and the habitat descriptions of other potoroo species although Bennett (1993) found some variety in the floristics and density of *P. tridactylus* in Victoria. Perhaps the study area does not represent the ideal habitat for Gilbert's Potoroo, and the species survived there in sub-optimal habitat because the area has been sheltered from bush fire and fox predation.

Some trapping and hair tube surveys have been conducted within and outside Two Peoples Bay in an attempt to determine the size and area of occupancy of the Two Peoples Bay population and to locate other populations outside the reserve. Trapping in Hakea Gully in early 1997 resulted in the capture of one old male that had probably been caught before. Animals trapped in previous years at South Firebreak and Hill 700 were not recaptured, although there is some evidence of a population in the West 6 area to the east of the Hill 700 site.

1.8 Strategy for Recovery

A Recovery Team will oversee the implementation of the Recovery Plan. Initially, the team will have the same membership as the Recovery Team that has overseen the implementation of the Interim Recovery

Plan (Start and Burbidge 1995). Membership will be modified from time to time to reflect changing circumstances of the members and to secure input from people able to contribute expertise that would enhance the recovery of Gilbert's Potoroo. Membership of the Team at December 1997 was:

Affiliation	Position	Present member
CALM South Coast Regn	Leader, Nature Conservation Program	Kelly Gillen (Chair)
CALM South Coast Regn	Manager, Two Peoples Bay N. R.	Alan Danks
CALM WATSCU	Director of WATSCU	Andrew Burbidge
CALM, Science & Inform	Principal Research Scientist	Tony Start
South Coast Community	South coast resident	Vic Smith
Edith Cowan University	Post-doctorate Fellow and project scientist	Jackie Courtenay
Environment Australia	TSCS; Potoroo Project Officer	Bruce Male
Agriculture WA	District Veterinary Officer	Kevin Ellard
Edith Cowan University	Biology Department	Alan Needham

The Recovery Team will report as required to CALM's Corporate Executive and to funding agencies.

This Recovery Plan has six strategies, all of which can be run concurrently. They are reflected in the Actions (Section 4)

1.8.1 Protection of existing populations

(a) Feral predators

Control of foxes has been shown to be one of the most effective strategies for recovering threatened medium-sized mammals in south western Australia (eg Start *et al.* 1997). Control of foxes will be a high priority. It will continue to be achieved by a combination of aerial baiting and strategic use of buried eggs containing 1080 on boundaries and internal roads. If foxes are noted in the reserve between baiting, programs, additional egg-baits will be laid within the reserve. Feral cats probably prey on potoroos and are present at Two Peoples Bay. CALM is developing techniques for control of feral cats. When a method that would be effective in that habitat is available it will be implemented. In the mean time cats will be destroyed opportunistically.

(b) Fire

Gilbert's Potoroo lives in long un-burned vegetation on Mt Gardner. Besides from any intrinsic significance of the age of the vegetation (which may be important), its density probably helps potoroos to avoid predators. Other medium-sized mammals such as Bandicoots (*Isoodon obesulus*) and Quokkas (*Setonix brachyurus*) which occur with potoroos on Mt Gardner, have disappeared from many habitats but persist in dense vegetation, presumably because of the protection it offers from predation.

Strategies for fire management in Two Peoples Bay have been prescribed in the Two Peoples Bay Management Plan (Orr *et al.* 1995). Low fuel buffers are maintained and new water tanks have been placed at strategic points on Mt. Gardner to provide a permanent source of water for fire fighting.

(c) Dieback

The pathogen *Phytophthora cinnamomi* is present on Mt Gardner and has caused dieback disease in some areas. Detailed resurvey shows that the affected areas are less extensive than had been provisionally mapped previously. Fine-scale mapping of areas where this and other fungal pathogens have affected the vegetation will be completed. The Two Peoples Bay Nature Reserve Management Plan prescribes measures to limit the spread of *P. cinnamomi* and stringent precautions are in place. At times these impede access to areas where potoroos live but prevention of spread is more important than rapid acquisition of information at a cost of habitat deterioration.

1.8.2 Search for additional populations

At present Gilbert's Potoroo has been trapped at a few sites on Mt Gardner and scats and hairs captured in hair-tubes indicate other sites where they may occur. It is difficult to relate sites to social groups or sub-populations because the social affiliations, home ranges and seasonal movements of individuals are not well known. Further survey work on Mt Gardner will clarify these issues.

Suitable habitat outside Two Peoples Bay Nature Reserve will be surveyed to determine whether Potoroo populations occur elsewhere. Hair tube surveys have been conducted at Torndirrup National Park, Gull Rock, Waychinicup National Park and on Mt Manypeaks. Both hair tubing and trapping have been conducted at Norman's Beach. Two single hairs, probably from Gilbert's Potoroo, were recovered from a gully near the summit of the Mt Manypeaks ridge on separate surveys. Mt Manypeaks will be the focus for surveys outside Two Peoples Bay Nature Reserve.

1.8.3 Population monitoring

Population monitoring will assess the effectiveness of management actions and ensure that the wild population is not in decline. Currently, the only known wild population that can be routinely trapped is at the East Firebreak and West 6 sites. Monitoring protocols will be developed.

1.8.4 Management of a captive colony

Management of the captive colony is essential for insurance against the loss of the wild population and to provide animals for translocation to new sites. The colony will be managed to maximise reproduction while maintaining genetic diversity. The colony also provides opportunities to investigate aspects of the species' behaviour and physiology that cannot be studied using the wild population. A captive management plan is in draft. The final document will guide management of the captive colony over the next 5 years. Where necessary it will be modified as genetic and behavioural information becomes available, and in accordance with predictive models from captive management computer programs such as SPARKS or the advice of experts in managing captive populations of threatened species.

The rate of increase of the captive colony has been very low. The reasons will be investigated and the suitability of novel methods to improve reproductive rates will be examined. These may include artificial insemination and cross-fostering.

1.8.5 Range extensions and translocations

The implementation of these strategies should allow Gilbert's Potoroo to naturally extend its range within Two Peoples Bay Nature Reserve. Habitat in other parts of the reserve will be managed to facilitate expansion. In addition, surplus animals from the captive colony will be translocated to other sites within the species' former range. Intensive post-release monitoring will be conducted to ensure the success of the translocation and to address any problems that arise.

1.8.6 Genetics

Genetic management of the captive colony to ensure that the population remains healthy and genetically viable is essential. It would also be useful to understand the relationships of wild individuals and to establish the extent of gene flow within the natural population. Prescriptions for manipulation of populations to optimise genetic conservation will be made after careful consideration of expert advice.

2. OBJECTIVES

1. Minimise the risk of catastrophic loss of the single known wild population by habitat management and maintenance of a genetically viable, captive-breeding colony.
2. Determine the present range and viability of wild populations.
3. Increase the size, number and viability of wild populations through habitat management, control of threatening processes, captive breeding and translocation.
4. Ensure that captive and wild populations maintain at least their present levels of genetic diversity.
5. Using internationally accepted criteria, down list the species from Critically Endangered to Endangered (IUCN 1994) within ten years.

3. RECOVERY CRITERIA

The criteria for achieving these objectives will be:

1. A self-sustaining, captive population of about 30 individuals producing surplus animals for translocation.
2. Hygiene, husbandry and genetic integrity of the captive colony is managed in accordance with a

comprehensive, written Working Plan to be prepared during 1998.

3. The distribution and resource requirements of Gilbert's Potoroo at Two Peoples Bay NR are documented.
4. A quantitative monitoring program records changes in population density and the area of occupancy of potoroos at Two Peoples Bay Nature Reserve.
5. Population density of potoroos on Mt Gardner is maintained or increased and the area of occupancy expands to sites beyond Mt. Gardner.
6. The occurrence of Gilbert's Potoroo beyond Two Peoples Bay NR, particularly on Mt Manypeaks, is determined.
7. At least two new self-sustaining populations are established by translocation of captive-bred stock.
8. By 2007 Gilbert's Potoroo is down-listed to endangered defined by IUCN 1994 Red List criteria.

4. RECOVERY ACTIONS

4.1 Appoint a scientist and a technical officer to implement the Recovery Plan

Implementation of this Recovery Plan will be the responsibility of a CALM Principal Research Scientist supported by a full time technical officer and assistance from District operations staff to cover feeding on weekends , surveys etc. Budgeting staff costs and providing vehicles could be proportionally allocated to all the remaining actions. However proportional allocation of costs to each action would be unnecessarily complicated and less accurate than treating them collectively. Thus they are calculated collectively under this Action.

Staff duties will include management of the captive colony, including feeding 365 days per year, and routine attendance to cage maintenance, hygiene, and animal monitoring. The prescriptions for these activities are covered in Action 3. The balance of their time will be spent monitoring the known wild population, searching for new populations and identifying the resource requirements of wild potoroos, etc., activities covered by the other Actions.

Item	1999		2000		2001	
	CALM	**EA**	**CALM**	**EA**	**CALM**	**EA**
Project Scientist (50% FTE)[1]	43 800	0	44 800	0	45 800	0
Project TO (100% FTE) [1]	0	40 500	0	41 500	0	42 500
Local support (30% FTE) [1]	17 500	0	18 000	0	18 500	0
Vehicle running[2]	0	11 200	0	11 700	0	12 200
Travel allowance [3]	0	3 000	0	3 000	0	3 000
Contributor Totals	61 300	54 700	62 800	56 200	64 300	57 700
Action Total	116 000		119 000		122 000	

[1] Includes real on costs (superannuation, workers' compensation, leave costs)
[2] 24 000 Km
[3] 60 days in field @ $50 per day

4.2 Develop and maintain a breeding colony of at least 30 potoroos plus surplus animals pending translocation

After the rediscovery of Gilbert's potoroo in 1994, one of the first management decisions was to keep some animals in captivity. There were two reasons. Firstly, as insurance; there was no evidence that the species existed anywhere but on Mt Gardner which is covered in highly flammable heath. A large wildfire could be catastrophic. Secondly, recovery would require the establishment of populations at other sites to increase the number of individuals and to spread the risk of catastrophes affecting most or all extant individuals. This decision was written into an Interim Recovery Plan (Start and Burbidge 1995).

Eight cages, designed specifically for the captive colony, were built in a low-fuel buffer zone in Two Peoples Bay Nature Reserve. At least fifteen pairs are required to maintain genetic diversity. Consequently constructing six more cages at the same site is enlarging the facility.

Gilbert's Potoroo is a 'highly strung' and very shy animal. Initially we experienced problems with

rejection of pouch-young. This problem seems to have been overcome. Nevertheless the breeding rate is very low. Diet and other husbandry factors will be manipulated to try to improve it. If these do not resolve the problem the Recovery Team will seek advice on methods such as artificial insemination. When the birth rate has been improved, cross-fostering may prove a useful method for increasing the rate of production of young potoroos. The Recovery Team is keen to support development of the method to a point it can be tried with confidence on Gilbert's Potoroo but, first, the birth rate must be improved and cross-fostering methods must be shown to work reliably with less threatened potoroos. Dr David Taggart of Monash University is doing this work. Funding is being sought by Dr Taggart with support from the Recovery Team, and is not included here.

WWF Australia has provided a grant to Wildlife Veterinary Services (Albany) to conduct a preliminary oestrous study. Veterinary attendance and management are required and funding is needed to support this work. The maintenance of the captive colony requires daily feeding and routine attendance to other issues.

Item	1999		2000		2001	
	CALM	**EA**	**CALM**	**EA**	**CALM**	**EA**
Food	0	3 000	0	3 500	0	4 000
Vet services (5 days/year) + pathology	0	3 000	0	3 000	0	3 000
Hygiene and other consumables	0	2 000	0	2 000	0	2 000
Fire protection - sprinkler system	0	3 000	0	0	0	0
Cage maintenance and equipment	2 000	1 000	2 000	1 000	2 000	1 000
Contributor Totals	2 000	12 000	2 000	9 500	2 000	10 000
Action Total	14 000		11 500		12 000	

4.3 Write and implement a Captive Management Plan and husbandry manual to oversee hygiene, husbandry and genetic integrity of the captive colony

The management of the captive colony requires a commitment to the highest possible standards of diet selection and preparation, husbandry, monitoring and hygiene as well as regular maintenance of the cages (which are built over natural vegetation). Furthermore, the mating of animals must be carefully managed to maintain genetic variability and minimise dominance by any one gene line. This becomes more critical with successive generations of captive-born animals. However, this can be complicated by social incompatibility between some individuals; they may not all get along with each other and females may reject some mates. The colony studbook is being managed by a software program, SPARKS, commonly used in zoos for this purpose.

Item	1999		2000		2001	
	CALM	**EA**	**CALM**	**EA**	**CALM**	**EA**
Write and implement Captive Management Plan	Costs are incorporated in other actions					
Action Total	0		0		0	

4.4 Investigate and document the distribution and resource requirements of Gilbert's Potoroo at Two Peoples Bay Nature Reserve

Gilbert's Potoroo appears difficult to trap, but this may be due to low numbers of animals. After the capture of five individuals when the species was rediscovered, 2 500 trap-nights at three sites yielded only one more animal. It is known from seven sites on Mt Gardner and at two it can be regularly caught. Dense vegetation, steep terrain and weather limit access to much of Mt Gardner. Because of the risk of spreading dieback diseases (see Action 4.6 - plant diseases) access is prohibited in wet weather when there is an increased risk of transporting infected soil. Safety dictates that access is also prohibited during periods of extreme fire hazard. Nevertheless, there are large parts of Mt Gardner that are probably suitable for Gilbert's Potoroo where neither traps nor hair-arches have been set.

There is some evidence of social groups occupying defined areas. This has come from trapping, radio-

tracking (but we have had difficulty with collar-rub injuring radio-collared animals - new collars are to be tried) and nylon-spooling (Vetten 1996). It is also significant that the habitat on Mt Gardner is very different from that in which Gilbert recorded Aborigines killing 'immense numbers' in 'dense thickets of spearwood and rank vegetation surrounding swamps or small running streams' in the 1840s (Gould 1863). There are areas that fit Gilbert's description in Two Peoples Bay Nature Reserve. Some trapping failed to locate any potoroos but until recently those areas sustained many foxes. They are intensively baited now.

Preliminary work suggests that Gilbert's Potoroo, like other potoroos, eats the fruiting bodies of mycorrhizal fungi for which it digs, leaving conical holes similar to those made by bandicoots. However almost nothing is known of the range of fungi species, their biology, seasonality or vascular hosts. It is important that this information is acquired so that the resource requirements of Gilbert's potoroo can be understood and the potential impact of dieback diseases on the principal food source can be determined.

This action will require more trapping and hair-arching on Mt Gardner and other parts of Two Peoples Bay Nature Reserve, as well as radio-tracking and diet analysis. Most of the resources are available and preliminary work on the mycorrhizal fungi of Mt Gardner has been commissioned through the support of WWF Australia. Nutritional analysis of fungi is required. Traps currently provided by Edith Cowan University will soon be unavailable and replacement traps need to be purchased.

Item	1999		2000		2001	
	CALM	**EA**	**CALM**	**EA**	**CALM**	**EA**
Traps (60 @ $40)	2 400	2 400	0	0	0	0
Nutritional analysis	0	500	0	0	0	0
Radio-tracking equipment	2 500	500	0	500	0	500
Consumables	0	500	0	500	0	500
Contributor Totals	4 900	3 900	0	1 000	0	1 000
Action Total	8 800		1 000		1 000	

4.5 Establish a quantitative monitoring program to record changes in population density and area of occupancy of wild Gilbert's Potoroo populations

Comment under Action 4.4 shows the need to establish routine monitoring protocols on Mt Gardner and in adjacent areas that conform to Gilbert's description of sites in which Gilbert's Potoroo was apparently abundant and in to which it may now be able to spread because of CALM's fox-baiting program. If potoroos are found on Mt Manypeaks, a monitoring program may be needed there too. Most materials are available. Time is the most important requirement.

Item	1999		2000		2001	
	CALM	**EA**	**CALM**	**EA**	**CALM**	**EA**
Consumables	0	500	0	500	0	500
Contributor Totals	0	500	0	500	0	500
Action Total	500		500		500	

4.6 Abate processes that may threaten or limit area of occupancy and/or population density of potoroos

Threatening processes that have been identified are:

Predation by cats and foxes. Cats are present on Mt Gardner and one radio-collared potoroo was taken by a predator, probably a cat. Foxes have also been very common in the area. Fox-baiting using 1080 in eggs has occurred for some years and this may have helped the persistence of potoroos on Mt Gardner. Nevertheless, in 1995 they were still common on areas adjacent to rabbit-infested farmland including the areas that apparently conform to John Gilbert's habitat description for the species. Since the discovery of the potoroos, baiting has been intensified and is maintained under CALM's Western Shield program. Poisoned eggs are still used near boundaries and on strategic tracks to minimise re-invasion between Western Shield baiting runs. CALM is working on broad-area cat control techniques and will control

cats when it is feasible to do so.

Plant diseases. The most serious plant diseases on Two Peoples Bay Nature Reserve are dieback diseases caused by *Phytophthora cinnamomi.* There is concern that these diseases could alter the structure of the habitat, adversely affecting potoroos, and eliminate many of the vascular hosts to the mycorrhizal fungi on which the potoroos are thought to depend. These concerns have prompted a re-evaluation of the occurrence of *Phytophthora* on Mt Gardner. While the pathogen is still causing disease expression, the situation is less severe than was thought in 1994.

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. CALM is developing broad-area methods for the control of dieback in addition to control of movement and activity. When this is available, and if dieback expression is sufficiently active to warrant it, these methods will be applied to potoroo habitat.

Fire. Fire is a constant threat. The vegetation of Two Peoples Bay Nature Reserve is highly flammable. However deep, damp gullies and extensive sheets of bare granite have probably ensured that some areas have escaped wildfires in the past. Fire may affect potoroos by creating areas that are un-inhabitable until regeneration replaces cover and/or food sources. Fire may also make potoroos more susceptible to predation because they lack sufficient cover to escape. CALM has a comprehensive fire management program for Two Peoples Bay Nature Reserve which was developed before the re-discovery of potoroos, but which is appropriate for potoroo management.

The prescriptions for habitat management are detailed in the Management Plan for Two Peoples Bay Nature Reserve which is current to 2005 (Orr *et al.* 1995). Furthermore, since the re-discovery of Gilbert's Potoroo predator control has intensified and is covered by the 'Western Shield' program as well as strategic supplementary baiting.

Item	1999		2000		2001	
	CALM	**EA**	**CALM**	**EA**	**CALM**	**EA**
Fox baiting	11 000	0	11 000	0	11 000	0
Plant disease control	2 000	0	2 000	0	2 000	0
Fire	3 000	0	3 000	0	3 000	0
Contributor Totals	16 000	0	16 000	0	16 000	0
Action Total	16 000		16 000		16 000	

4.7 Search for potoroos outside Two Peoples Bay Nature Reserve

It is possible that there are extant populations of Gilbert's Potoroo in addition to the one in Two Peoples Bay Nature Reserve. A highly prospective site is Mt Manypeaks, which is separated from Mt Gardner by Two Peoples Bay itself. Most of the land between the two mountains is alienated. However Mt Manypeaks is substantially larger than Mt Gardner and has extensive areas of long un-burned dense vegetation. Although there have been large wild fires on the mountain it is unlikely that the whole area of potential potoroo habitat has burned at one time.

Two single hairs, probably from Gilbert's Potoroos, have been recovered in hair arches set near the top of Mt Manypeaks. Although both came from the same site, they were recovered in different years. Mt Manypeaks is a rugged area of steep terrain and dense vegetation, which is subject to sudden changes to inclement weather at any time of year. The vegetation is highly susceptible to dieback diseases so that any work on the mountain must be conducted with minimal risk of spreading *Phytophthora.* There is no vehicle access except to occasional points near its base.

Hair arches or hair tubes are the most efficient and cost-effective method for initial survey because they are light weight, can be carried in and left for some time before collection. Gilbert's Potoroo hair can be easily distinguished from that of all other species in the area except quokka. A method for distinguishing

these two species has been developed (unpublished data) and equipment including a microscope has been obtained. However, it will be necessary to confirm the presence of potoroos and the extent of occurrence by trapping or the use of weather-proof, remote-operated cameras. Cameras will be costly items to purchase and trapping will require helicopter transport to a base camp on the mountain. W plan two surveys per year. The helicopter will have to be ferried from Perth .

Other equipment is already available, but consumables, including double-sided tape and bait, will be required. During the three years costed here, effort will be concentrated on Mt Manypeaks unless evidence from other sources indicates the presence of potoroos elsewhere.

Item	1999		2000		2001	
	CALM	**EA**	**CALM**	**EA**	**CALM**	**EA**
Search on Mt Manypeaks	0	10 000	0	10 000	0	10 000
Contributor Totals	0	10 000	0	10 000	0	10 000
Action Total	10 000		10 000		10 000	

4.8 Establish new populations by translocation

An objective of the Recovery Plan is to increase the number of populations by translocation using surplus animals from the captive colony as founder stock. A criterion for success is that at least two new self-sustaining populations are established by translocation of captive-bred stock by the end of the ten year life of the plan. The recipient sites will be determined when the natural distribution of extant populations and the natural resource requirements and limiting factors of the species are better known.

This Action is likely to occur after the three year program costed here because of the very slow breeding rate of Gilbert's potoroos in captivity so far. Nevertheless it is possible that the reproductive rate may be increased by changes of diet, husbandry or by cross-fostering or artificial insemination. Therefore a costing is estimated for 2001 in case it is achievable by then. If it is not, EA contributions will be deleted from the 2001 budget estimate when contracts are being negotiated. The cost is a rough estimate at this stage as actual costs will depend on many, as yet unknown, factors including the possible recipient sites.

Item	1999		2000		2001	
	CALM	**EA**	**CALM**	**EA**	**CALM**	**EA**
Translocation	0	0	0	0	0	5 000
Consumables	0	0	0	0	0	500
Contributor Totals	0	0	0	0	0	5 500
Action Total	0		0		5 500	

4.9 Review the conservation status of Gilbert's Potoroo according to IUCN criteria in 2007

This Action will occur after the three year program costed here.

Item	1999		2000		2001	
	CALM	**EA**	**CALM**	**EA**	**CALM**	**EA**
Review conservation status	This Action will occur after the three year program costed here					
Action Total	0		0		0	

4.10Review the Recovery Plan.

While the recovery of Gilbert's Potoroo will probably take at least ten years, this edition of the Recovery Plan has been costed for three years. The Recovery Team will review the Recovery Plan, progress and further resource requirements during the third year, in 2001.

Item	1999		2000		2001	
	CALM	**EA**	**CALM**	**EA**	**CALM**	**EA**
Review Recovery Plan	0	0	0	0	0	0
Contributor Totals	0	0	0	0	1000	0

Action Total	0	0	1000

Budget Summary

Item	1999		2000		2001	
	CALM	**EA**	**CALM**	**EA**	**CALM**	**EA**
Action 1	61 300	54 700	62 800	56 200	64 300	57 700
Action 2	2 000	12 000	2 000	9 500	2 000	10 000
Action 3	0	0	0	0	0	0
Action 4	4 900	3 900	0	1 000	0	1 000
Action 5	0	500	0	500	0	500
Action 6	16 000	0	16 000	0	16 000	0
Action 7	0	10 000	0	10 000	0	10 000
Action 8	0	0	0	0	0	5 500
Action 9	0	0	0	0	0	0
Action 10	0	0	0	0	0	1 000
Participant total	82 200	81 100	80 800	77 200	82 300	85 700
Action Total	163 300		158 000		168 000	

5. ACKNOWLEDGMENTS

We acknowledge with gratitude the resource contributions made by Environment Australia, the Department of Conservation and Land Management, Edith Cowan University and the World Wide Fund for Nature and University. Besides these institutional contributors many people have given their own time to progress the recovery of Gilbert's Potoroo.

We are grateful to the members of the Recovery Team who have helped to see Recovery of the species to its present state. Liz Sinclair, who was a member until she moved overseas, has made a substantial contribution. Dr. Kevin Ellard (who joined the team recently) and Dr David Forshaw of Agriculture Western Australia have provided valuable advice and investigated various health issues. The staff of Healesville Sanctuary have been generous with their advice on management of animals in the captive colony.

6. BIBLIOGRAPHY

Calaby, J.H., 1971. The current status of Australian Macropodidae. *Australian Zoology.* **16:** 17-29

Calaby, J.H. And Richardson, B.J. 1988. *Potoroidae.* In: Walton, D.W. (Executive Editor) *Zoological Catalogue of Australia: Vol 5. Mammalia.* Australian Government Publishing Service. Canberra.

Dortch, C., and Merrilees, D., 1971. A salvage excavation in Devil's Lair, Western Australia. *Journal of the Royal Society of Western Australia.* **54(2):** 103-113.

Gould, J., 1841. *Monograph of the Macropodidae or family of Kangaroos.* Part 1. J. Gould, London.

Gould, J., 1863. *The Mammals of Australia* J. Gould, London.

Guiler, E.R., 1961. Notes on the externals of the Potoroo, *Potorous tridactylus* (Kerr). *Papers and Proceedings of the Royal Society of Tasmania.* **96:**41-48

Guiler, E.R. and Kitchener, D.A., 1967. Further Observations on longevity in the wild Potoroo, *Potorous tridactylus. Australian Journal of Science.* **30(3):** 105-106

IUCN (1994). *IUCN Red List categories.* Prepared by the IUCN Species Survival Commission. Gland, Switzerland.

IUCN (1996). *The 1996 IUCN List of Threatened Animals.* IUCN Gland, Switzerland.

Johnston. P.G., 1995. Long-nosed Potoroo *Potorous tridactylus* (Kerr, 1792). In: R. Strahan (Ed) *The Mammals of Australia.* Reed Books, Chatswood, New South Wales. pp 301-302.

Orr, K., Danks, A. and Gillen, K., 1995. *Two Peoples Bay Nature Reserve Management Plan 1995-2005.* Department of Conservation and Land Management, Perth.

Ride, W.D.L., 1970. *A guide to the native mammals of Australia.* Oxford University Press, Melbourne.

Seebeck, J. 1982. Long-nosed Potoroo *Potorous tridactylus*: Husbandry and management of a captive colony. In: D.D. Evans (Ed) *The Management of Australian Animals in Captivity.*

Seebeck, J., 1992. Breeding, growth and development of captive *Potorous longipes* (Marsupialia:

Potoroidae), and a comparison with *P. tridactylus*. *Australian Mammalogy*. **15:** 37-45.
Serena, M., Bell, L. and Booth, R.J., 1996. Reproductive behaviour of the Long-footed Potoroo (*Potorous longipes*) in captivity, with an estimate of gestation length. *Australian Mammalogy* **19:** 57-61.
Shaw, G. and Rose, R.W., 1979. Delayed gestation in the Potoroo *Potorous tridactylus* (Kerr) *Australian Journal of Zoology*. **27:** 901-912.
Sinclair, E.A., Danks, A. and Wayne, A., 1996. Rediscovery of Gilbert's potoroo, *Potorous tridactylus*, in Western Australia. *Australian Mammalogy* **19**: 69-72.
Sinclair, E.A., and Westerman, M., 1997. Phylogenetic relationships within the genus *Potorous* (Marsupialia: Potoroidae) based on allozyme electrophoresis and sequence analysis of the cytochrome *b* gene. *Journal of Mammalian Evolution*. **4(3):** 147-161.
Snyder, N.F.R., Derrickson, S.R., Beissinger, S.R., Wiley, J.W., Smith, T.B., Toone, W.D. and Miller, B., 1996. Limitations of Captive Breeding in Endangered Species Recovery *Conservation Biology* **10(2):** 338-348.
Start, A.N. and Burbidge, A.A., 1995 *Interim Recovery Plan for Gilbert's Potoroo* (Potorous tridactylus gilbertii). Unpublished report. Department of Conservation and Land Management, Perth.
Start, A.N., Burbidge, A.A. and Armstrong, D. 1997. A review of the conservation status of the Woylie, *Bettongia penicillata ogilbyi* (Marsupialia: Potoroidae) using IUCN criteria. *CALMScience* **2(4):** 277-289.
Temple-Smith, P. and Taggart, D., 1994. *Analysis and interpretation of Potoroo testicular biopsies*. Unpublished report to Healesville Sanctuary, Victoria.
Tory, M.K., May, T.W., Keane, P.J. and Bennett, A.F., 1997. Mycophagy in small mammals: A comparison of the occurrence and diversity of hypogeal fungi in the diet of the long-nosed potoroo *Potorous tridactylus* and the bush rat *Rattus fuscipes* from southwestern Victoria, Australia.
Ullman, S.L. and Brown, R., 1983. Further observations on the Potoroo (*Potorous tridactylus*) in captivity. *Laboratory Animals* **17:** 133-37.
Vetten, S., 1996. *Microhabitat use in Gilbert's Potoroo* Potorous tridactylus gilbertii *in relation to vegetation associations and ground cover*. Unpublished Honours Thesis, Department of Applied Science, Edith Cowan University, Perth.