GILBERT'S POTOROO RECOVERY TEAM

ANNUAL REPORT

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SUMMARY

Management of threats to Gilbert's Potoroo (fire and feral predators) was continued under the Two Peoples Bay Management Plan and the Noisy Scrub-bird Recovery Plan. Surveys for dieback infected areas were also continued by Alan Danks and Mal Grant. A slashed low fuel buffer was established around the Potoroo captive breeding facility, and a compacted gravel strip established around the immediate perimeter of the pens as part of a mouse barrier acts as a further fuel free buffer.

Extensive hair tube surveys were conducted on Mt Manypeaks and the Tick Flat area of Mt Gardner, and several other areas of Mt Gardner were also surveyed using this method. One Potoroo hair was obtained from Mt Manypeaks. Probable Potoroo scats were found in the West 6 area of Mt Gardner and a trap line established in late 1997 although no Potoroos have yet been captured. Trapping was repeated at a number of sites where Potoroos had previously been caught. A new juvenile female was caught at East Firebreak, and an aged male was caught at Hakea. Trapping at other sites (new and "known") failed to either recapture known animals, or find any new populations.

Reproduction in the captive colony has been limited to one breeding pair who produced two young in 1997. Other females had access to males but did not conceive. Two animals (an old female and her unweaned young) died in early 1997 so the total number of animals in the colony remained unchanged at 12 (plus one pouch young). Low light cameras and video system have been obtained enabling four cages to be monitored simultaneously. A detailed study of reproductive behaviour was conducted by an Edith Cowan University Honours student and results are expected in the near future. The slow rate of breeding in the captive colony has highlighted the urgent need for studies of diet and social structure of the wild populations, as well as investigations of reproductive status of the captives.

Genetic studies using microsatellite markers have been completed by Elizabeth Sinclair. Further genetic work using mtDNA would be desirable to better understand the population structure and the extent of any bottleneck that has occurred.

1. INTRODUCTION

1.1 Background

The Interim Recovery Plan (IRP) for Gilbert's Potoroo identifies a range of management and research actions required for the recovery of this species. The main protective management actions (fire management, dieback and feral predator control) are implemented under the Two Peoples Bay Management Plan, and the Noisy Scrub-bird Recovery Plan. The primary focus of the Gilbert's Potoroo recovery program in 1997 has therefore been on the remaining management issues (maintenance of the captive breeding colony and search for other Potoroo populations) and on addressing some of the research issues. The stated goal of establishing the captive colony was to provide insurance against loss of the parent population and to provide animals for future translocation. The increasing size of the captive colony, their total dependence on human care, and improvements in husbandry methods have meant that care of the captive colony has necessarily become an increasingly time consuming aspect of the project. As a result, other aspects of the project, specifically trapping and some research questions have received less attention. This report addresses the actions specified in the Interim Recovery Plan for Gilbert's Potoroo (*Potorous gilbertii*) and discusses progress on these actions in 1997.

1.2 Recovery Team

Recovery Team meetings were held on June 19th and December 4th. Recovery Team membership at the end of 1997 was:

Kelly Gillen (Chair)	CALM, South Coast Region
Alan Danks	CALM, Two Peoples Bay NR
Tony Start	Supervising Scientist, CALM, SID
Elizabeth Sinclair	UWA Zoology Department
Vic Smith	Representing local conservation groups
Andrew Burbidge	CALM, WATSCU
Jackie Courtenay	Scientist, Two Peoples Bay, ECU Applied Science
Bruce Male	Environment Australia Endangered Species Unit
Alan Needham	ECU Applied Science
Kevin Ellard	Wildlife Veterinary Services

Alan Needham and Kevin Ellard were new additions to the Recovery Team for the December meeting (Kevin was present as an observer at the June meeting), and Elizabeth Sinclair will be leaving the Recovery Team as of the end of 1997.

2. RECOVERY PLAN AND FUNDING

A first draft of a full Recovery Plan was completed in October and is currently being reviewed by Recovery Team members. Funding under the IRP is being reviewed for 1998 in the light of the greatly increased costs of husbandry (including veterinary care) over the originally budgeted levels, and the need for other additional resources for example for the installation of a pump and sprinkler system in the captive breeding facility, the need for a new refrigerator in the facility and for replacement of the 60 traps currently on loan from Edith Cowan University.

3. MANAGEMENT/MONITORING

3.1 Fire

Mechanical slashing of the vegetation in the low fuel buffer zone was continued in 1997 and a 40 m wide low fuel buffer was also established across the isthmus paralleling Sinker Reef Track. This second buffer completely separates Mt. Gardner from the Lakes area. In addition, a slashed low fuel buffer has been established around the potoroo captive breeding facility. The compacted gravel strip established around the immediate perimeter of the pens as part of a mouse barrier acts as a further fuel free buffer. Vegetation within the pens has been trimmed down to a minimum of 30cm below the cage roof, both to ensure that no vegetation is poking through the mesh which could damage the mesh and provide a fire hazard, and to encourage "bushing" of the vegetation at ground level to provide more cover for the animals.

No significant fires occurred within Two Peoples Bay Nature Reserve in 1997, although a lightning strike in April resulted in a very small area (about $10m^2$) being burnt in the Upper Tick Flat Area. The fire was extinguished by rain associated with the lightning storm and the burnt area was only discovered a few weeks later when a hair tube survey line was being established in the area.

An underground power line was installed and mains power connected to the Reserve in August. This has had immediate benefits as far as general convenience, and has also removed one of the major barriers (ie no power source for a pump) to installing a sprinkler system at the Potoroo breeding facility. The

presence of mains power means that is now possible to sink a bore and run a pump to provide water for the sprinkler system although funding for the system is still required.

3.2 Dieback Disease

The program of surveys conducted by Alan Danks and Mal Grant to map the occurrence of dieback disease in the Mt Gardner area continued in 1997. Areas surveyed included the Lower Firebreak Valley around the northern end of Tank Ridge to Lower Tick Flat. Dieback was found to be present in the lower parts of this area roughly paralleling the Main Rd, Little Beach Rd, Sinker Reef Rd and the Lower Tick Flat-Wave Sign track. Lower Firebreak Valley south of the dune ridge and the higher land on Tank Ridge was free of any sign of dieback. Surveys will continue in 1998.

3.3 Feral Predators

Chicken eggs impregnated with 1080 were buried along reserve tracks during the period May to September. Aerial baiting of the Reserve using dried meat baits was carried out in association with the Western Shield program in March, October and December. Additional baiting with dried meat baits was carried out whenever fresh fox sign was noted.

3.4 Monitoring

3.4.1 Monitoring Transect

A 6.7.km monitoring transect established along the main management track system on Mt Gardner in September 1996 was retrapped in September 1997 with the addition of a large or a small Elliott trap at each site. Again only a single Gilbert's Potoroo was trapped in the vicinity of the East Firebreak population. The identity of the individual was not determined because the lock bar failed to drop completely (no obstruction was apparent when it was checked either before or after the capture) and the animal escaped when the trap was approached. It is likely that it was, however, the same East Firebreak female that was spooled to that area by Sarah Vetten and was captured (at an adjacent trap point about 100m from the 1997 capture) during the 1996 transect trapping. Trapping of the transect will be repeated annually and it is anticipated that as the population of Gilbert's Potoroo increases this transect will be useful for a general monitoring of population size.

3.4.2 Retrapping of sites of "known" populations

Retrapping of several areas where Potoroos had previously been trapped was carried out to clarify the status of those animals (including inserting Trovans to ensure identity) and to determine whether the Hakea area had been recolonised after the initial four animals were removed for the captive colony. All sites except Upper Robinsons and North Firebreak where Potoroos had previously been caught were retrapped. The results of the trapping are summarised in Table 1.

Table 1: Results of trapping at sites where Potoroos have previously been captured.

Site	Trap nights	Potoroos	Other species
South Firebreak	170	None	Bush Rat, Quenda, Quokka
Hakea	440	1 aged male. Possibly=#9	Bush Rat, Quenda, Quokka, King skink
Hill 700	164	None	Bush Rat, Quenda, Quokka
East Firebreak	100	12 (7 individuals). Between 1 and 4 individuals caught each night	Bush Rat, Quenda

As can be seen from the Table, the previously known animals from South Firebreak and Hill 700 were not recaught. The one individual captured at Hakea (#31) was an aged male. He appeared to have been ear punched but it was not possible to make sense of the number (relative to any known animals). Genetic analysis revealed that this animal had exactly the same genotype over 6 nuclear DNA loci as male #9 who was originally trapped at several sites including North Firebreak and Upper Robinsons but has not been retrapped since July 1995. It is therefore possible that these two are the same animal (although some other animals which are known to be different individuals also have identical genotypes so the identity of #9 and #31 is not entirely certain). All known adult animals from East Firebreak were recaptured in 1997, and a juvenile female was also caught. Retrapping of the North Firebreak site which originally had 4 individuals (including male #9) is planned for 1998.

4. IMPLEMENTATION OF SCOPE ITEMS

4.1 Home range and use of habitats

No radio tracking was carried out in 1997. Radio-tracking of the known population at East Firebreak was not considered a high priority, and only one other new animal was caught (at Hakea). The animal was not collared immediately and was never recaught. Discussions about lighter transmitters and softer collars were carried out with David Titley (Titley Electronics) and Ross Meggs (Faunatech) and sample collars

were received. Discussions with other CALM staff involved in radio-tracking revealed, however, that Biotrack collars (the ones we already have) are by far the most reliable, and in a species which can be difficult to locate and retrap (if not originally caught in a core area), and which suffers so badly from collar chafe, it was felt that the higher risk of collar failure in other brands was not acceptable. It was therefore decided to use existing (Biotrack) collars lined with sheepskin or to investigate surgical rubber collars which could be made up by Biotrack when collars are being rebatteried. Sheepskin lined collars are currently being trailed. It is planned for new animals caught to be radio-tracked (if appropriate eg they are adult, not carrying large pouch young etc) for a short period (less than two weeks) to determine their home range and resting areas. Retrapping in the resting areas may result in other individuals being caught as well (as occurred at East Firebreak in 1996), and will hopefully avoid the problem experienced at several sites (Hakea, Hill 700 and South Firebreak) where an animal was trapped once and then disappeared.

Apparent compatibility problems in the captive colony (see Section 5.3) have also highlighted the need for more detailed study of the social organisation of the wild population including home ranges, association patterns and genetics (paternity) of young. Such a study would enable better planning of the housing arrangements (pairs versus polygamous or multi-male groups etc). A detailed study involving spooling, radio-tracking and genetic analysis of the population could resolve this question but would require a considerable time commitment and might best be approached as a PhD study if additional funding could be obtained.

4.2 Locate other Populations

4.2.1 Hair tubing

Hair tube surveys were carried out at Mt Manypeaks, Tick Flat, Lower Hakea, West 6, and East Firebreak during 1997. Hair analysis has been almost completed for Mt. Manypeaks and Tick Flat (the two largest surveys), and West 6 (see Table 2). Analysis is conducted in two stages - a pre-sort which involves identifying which hairs are Quokka or Potoroo (QP) followed by microscopic analysis of the QP hairs only. Some apparent inconsistencies in the hair analysis technique (ie hairs that looked like Quokka all along their length except for a small section with Potoroo type structure) were experienced when analysing the hairs from Manypeaks and it was felt that expert advice was needed before too much time was invested in further analyses. Comparisons of a number of known Potoroo and Quokka hairs were made but did not resolve the concern that Potoroos may be being missed if the hair was not examined along its entire length. Barbara Triggs and Hans Brunner were telephoned for advice on both preservation techniques and analysis. Hans Brunner volunteered to examine a series of hairs and in

December returned a similar technique for identifying hairs to the one developed by Wes Manson, and also noted that only primary guard hairs of a minimum thickness are distinguishable (which was also Wes Manson's experience), and only at the section of the hair nearest the banding fleck. This clarifies the uncertainty and indicates that the identification technique that has been used to date, while limited to primary guard hairs with a clear fleck, has been reliable and further analyses can continue with greater confidence. The main analyses (Manypeaks and Tick Flat) have been completed, although it may be worthwhile to re-examine some of the Manypeaks hair to ensure that the correct section of the hair has been examined in every case.

The single hair that was apparently from Gilbert's Potoroo was recovered from the same gully near the top of Mt. Manypeaks where a single hair was recovered in 1996. Although only one hair was found, the collections were conducted with careful attention to hygiene and all hairs were marked in the field to minimise the chance of a contamination hair being identified as evidence from the site. The Potoroo hair found had been noted in the field, so the likelihood of contamination seems low.

Table 2: Sites surveyed using hair tubes and results of hair analyses

Site	# of tubes	Analyses		Results
		Pre-sort	Microscope	
Manypeaks Area 1	100	Completed	Completed	1 Potoroo hair
Manypeaks Area 2	175	Completed	80% done	No Potoroo
Tick Flat	250	Completed	N/A	No QP hair
Lower Tick Flat North	40	Completed	1 to check	Only 1 ?QP hair.
Lower Hakea	50	Completed	1 to check	Only 1 ?QP hair
East Firebreak	30	Completed	To do	11/30 have QP
West 6	72	Completed	25% done	Only 4 to analyse, most hairs too fine

4.2.2 Trapping

New trap lines were established at Robinson's Corner and West 6. The trap line at Robinson's Corner was established because small macropod-like tracks had been observed in the soft sand of the track over several days, and the site was also between Hakea and Upper Robinsons and it was felt that it might enable recapture of the "disappeared" Hakea male. Trapping at Robinson's Corner failed to catch any Potoroos, although a young female Quokka was caught on several occasions so it is likely that she was responsible for the tracks. Other species caught were Bush Rat, Quenda and Mardo (*Antechinus flavipes*).

A new trap line was established at West 6 following the discovery of several scats which were apparently Potoroo, and a hair tube survey. A 15 trap line was established in November and a further 25 traps added

in December. This second group of traps was placed through fairly thick vegetation and took 7 people (myself and 6 volunteers) 4 hours to place and set. This quite clearly illustrates the huge amount of time involved in establishing trap lines in this environment and the importance of having sufficient traps available so that new trap lines can be established without the need to move traps from other locations. Currently the program owns forty traps and another sixty are on loan from Edith Cowan University. Edith Cowan University will not, however, be continuing its involvement with this project beyond the end of March 1998 and the traps will need to be returned. Two nights trapping was carried out on this line but only bush rats *Rattus fuscipes* were captured. Further trapping is planned for early 1998.

A single Potoroo was also trapped along the main Firebreak Valley road during trapping undertaken for a third year student project (see section 3.4.1).

4.3 Diet

Dietary investigations were considered of Low to Moderate priority in the IRP. The low rate of reproduction in the captive colony (see below) has, however, highlighted the urgent need for detailed investigations of the diet of this species to ensure that there is no major nutrient deficiency that could be affecting reproductive performance. The effect of deficiency in particular nutrients on reproduction of otherwise apparently healthy captive animals is well documented in the literature (see Asa, 1996 for review) and experience with the captive breeding of Numbats in Western Australia clearly highlighted the importance of an appropriate diet, especially for animals that have specialist feeding habits.

As a first step towards this study, scats have been regularly collected from wild trapped animals and preserved for later analysis. Katie Syme and Denmark Environment Centre have applied for WWF and Cheryl Edwardes Community Conservation Grants (both $5000) to conduct surveys for hypogeal fungi in areas of known Potoroo populations and to collect samples as the first stage in a dietary study of the Potoroos. Trapping of animals and collection of scats will be carried out concurrently with the surveys to ensure comparable data on dietary availability and consumption. Costings for analysis of the scats by fungi experts have not been finalised but early indications are that the costs will be quite high per day. Costs can, however, be minimised to some degree by limiting the number of specimens analysed and the level of identification requested. Most of the hypogeal fungi at Two Peoples Bay are undescribed species, but provided it is possible to identify the different species by their spores and to relate the spores in the scat to the fruiting body which can be nutritionally analysed, full taxonomic identification is probably unnecessary.

4.4 Dieback Disease

Progress on dieback surveys on Mt Gardner was reported in section 3.2 above. Section 2.3.5 of the IRP listed 3 methods for investigation of dieback disease. Method (a) - mapping of the occurrence of dieback disease within the Mt Gardner area is progressing. The priority of Method (b) identifying susceptible species in Potoroo habitats and determining their significance to habitat structure and (c) identify susceptible species in the potoroo habitats and assess their significance to potoroo diets, was dependant on the outcome of the surveys. These studies are also, however, dependant upon studies of both habitat requirements and diet. Detailed dietary studies have not been undertaken (considered Low priority in the IRP), and other than the microhabitat study conducted by Vetten (1996) habitat use studies have been limited by time constraints. No further action has therefore been possible on either of these two methods.

5. CAPTIVE BREEDING

5.1 Colony status

At the beginning of 1997 the captive colony consisted of 12 individuals - four adult females (one with pouch young), four adult males, three subadult/young adult females and a juvenile male. Two of the three young females and the young male had been conceived in captivity in late 1995. The remaining young female had come into the colony in the pouch when her mother (#17) was captured in April 1996. The young female (#29) born in October 1996 to female #17 exited the pouch in February 1997. During 1997, two animals died (see 5.2 below) and two were born. The colony at the end of 1997 therefore still consists of 12 individuals plus one pouch young. The sex ratio is 7 females - 3 reproductive adult, 3 young adult (at least 2 years old but have not bred) and one juvenile, and 5 males - 3 reproductive adult and 2 young/non-reproductive adult (18 months and 3.5 years respectively). The age at which individuals reach sexual maturity is not known for sure, however, male #6 fathered his first (and only) infant at 14 months. Since in most mammals females reach sexual maturity at a younger age than males, all animals except for the juvenile female could be expected to be sexually mature.

5.2 Mortality

Two animals died during 1997 - Female #17 and her unweaned young Female #29.

On March 19th, Female #17 was found dead in the cage. This female had been caught at North Firebreak in April 1996 with a large female pouch young (#27) and brought into the colony. The high degree of

tooth wear indicated that she was an old animal (although probably younger than Female #4). Autopsy revealed that she had a build up of oxalate crystals in the kidneys. Possible causes are excessive oxalate in the diet, inadequacy of Vitamin B6 (which assists in the metabolism of oxalate), spoilage of food, excessive Vitamin C or metabolic failure.

The diet was analysed for oxalate by the Perth Laboratories of Agriculture WA and found to be completely oxalate free, ruling out a dietary origin. There was a possibility that oxalate could have been ingested in mould on the *ad libitum* dog food cubes and pepitas that were left in the cages, although no mould was visible on these foods. Nevertheless, this practice was discontinued and these food items are now supplied with the meal each night. All other food items have always been supplied very fresh. Vitamin B6 which assists in the metabolism of oxalate was also increased in the diet through the inclusion of meal worms. An up to date diet sheet was obtained from Healesville Sanctuary (which has not experienced oxalate problems with their potoroos, although the condition is known from other marsupial species such as Koalas, Scaly tailed Possums and Parma wallabies at other institutions). Other dietary modifications were implemented although some of the new foods (sprouted wheat and oranges) were refused by the animals and have not been continued in the diet. While no firm conclusions could be drawn as to the cause of the oxalate build up in this animal, dietary sources were ruled out, and a lack of B6 was thought unlikely by the vet as other symptoms of B6 deficiency were absent. In the absence of an obvious dietary source, it seems most likely that the condition occurred as a result of metabolic breakdown caused by lactational stress in an old animal.

Following the death of her mother, the unweaned young-at-heel (#29) was initially taken to my home for hand rearing. The young Potoroo was kept at home for five days housed in a modified cat trap with a hot water bottle (well wrapped up) for warmth. "Divetalact", a lactose free veterinary milk, was offered at 4-6 hourly intervals and she was supplied with a dish of food to eat *ad libitum* (this included apple, dried currants, rolled oats, carrot, and mushroom) and fresh water. After four days she was accepting the teat well and also eating the solid food offered and had gained 7.5 grams of weight, and now weighed 301 g. However, she was showing signs of scouring (even though the milk was made up at half strength) and distress at being confined to such a small cage when she was used to 10m x 3m. Examination of past trapping data indicated that Male #6 had been brought into the colony without his mother at an even smaller size (286.5g) and had survived the enforced weaning. It was therefore decided to return the female to her cage and to check her for movement every day and monitor her weight gain weekly. She was moved in with the old Female #4 on 27th March.

On Saturday 26th April 1997, a month after being returned to the colony, Female #29 was found dead on the floor of the cage. She had last been handled on 19th April and although she was still very small for

her age she had gained a small amount of weight (although nowhere near the 42g that would have been expected). She had apparently been dead for a few days as the body was very decomposed. She had not been checked in the previous few days as work was being conducted on finishing the prep. room area, including sealing the floors and it was felt that with all the noise and activity occurring in the pen area it was better not to further stress the animals by entering the cage to flush them. This decision, combined with the strong smell of paint from the floor sealing, meant that the animal's death was not immediately noticed.

An autopsy was carried out but because of the advanced stage of decomposition, no histological analysis could be undertaken. In a telephone conversation between myself and Kevin Ellard he stated that he did not believe the animal had starved to death although it was difficult to be certain given the degree of decomposition. He also noted that the darkened tissue in the thorax appeared similar to bruising and it was therefore possible that the animal had died from an injury perhaps sustained by jumping onto a sharp stick, although it was again impossible to draw any firm conclusions. The unavoidable delay in finding the body of this animal means that we will never know the cause of death for certain. Nevertheless, it appears that she was already undernourished at the time of her mother's death, and she never really thrived afterwards. The more detailed growth information that we have obtained through the regular handling of subsequent pouch young means that we now have good growth curves that would enable us to recognise immediately if an animal was undersize or not growing adequately and thus take more effective action.

The death highlighted the need for a better method of monitoring multiply housed animals than simply recording food intake. Two recommendations were made in the "Report on the Death of Female #29" (see section 4) (a) the construction of an isolation cage to isolate "at risk" animals and (b) the acquisition of a video camera set up with at least two cameras to have as a permanent fixture in the potoroo pens. Money was obtained from the Bankwest *Landscope* Conservation Visa Card fund to purchase four low light cameras, lights, a video, quad splitter and a monitor. The cameras, lights and monitor were purchased and the video and quad splitter obtained on loan from SONY for the duration of an Honours project on captive behaviour (see discussions under reproduction and student projects). This equipment now needs to be returned to SONY, and the items replaced from what remains of the Visa card grant, although a small amount of top up funding may be required. It is now possible to monitor up to four cages simultaneously without disturbing the animals. The construction of an isolation pen is still considered a worthwhile action when funding is available.

5.3 Reproduction

Two young were born during 1997, both to the same parents (#10 and #3). In both cases the young was conceived within a few weeks of the parents being housed together. All other females (except the old female #4) were paired with males throughout the year but without success. It is possible that the young females were too young to be sexually mature in the early part of the year, and that winter may be a non-breeding season. All three have, however, been paired with males all spring and none have yet conceived. Female #1 has also not conceived since November 1995 despite having been housed with three different males, including the father of her 1995 young.

Table 3 records the pairing histories of all the females in the colony including which males are preferred (unrelated) mates and the outcomes of any pairings.

Table 3 Reproductive histories of the female Gilbert's Potoroos including dates of pairing and outcome.

Female	**Preferred males ("unrelated")**	**Pairings Attempted**		
		Male #	**Dates**	**Outcome**
#1	#3, #6, #7, #11, #28 (1)	3	11/5/96-14/11/96	No py.
		6	11/10/95-9/1/96	#18
			14/11/96-27/3/97	No py
			6/11/97- present	No py
		7	27/3/96-6/11/97	No py
#4	#3 (2), #6, #11, #28(2)	3	13/7/95-11/10/95	No py. Aggression resulting in tail damage to female
		6	16/5/96-14/8/96	No py
		11	31/10/96-10/12/96	No py. Aggression resulting in bite to ankle of female leading to arthritis.
#10	#3, #6, #7	3	12/10/95-28/11/95	#19, #28
			30/1/97-27/3/97	#32
			6/11/97-14/1/98	py born ≈ 27/12/97
		6	14/8/96-14/11/96	No py
			27/3/97-2/5/97	No py(3)
#17(4)	N/A	11	14/8/96-20/9/96	#29
#18	#3, #7, #11, #28	7	31/10/96-6/11/97	No py
		11	6/11/97-present	No py
#19	#6, #7	6	27/3/97-6/11/97	No py
		7	6/11/97-present	No py
#27	#3, #6, #7, #11, #28	3	27/3/97-6/11/97	No py
		7	6/11/97-	No py

(1) Genetics indicate that #4 is possibly the mother of both #3 and #1, as well as #7. If this is the case, #7 is at least #1's half-brother, and #28 is her half-nephew.
(2) Genetics indicate that #3 could be her son, in which case #28 is her grandson. The others are probably unrelated.
(3) The young female #32 was born during this period. Female #10 would therefore have experienced a post-partum oestrus while she was paired with this male but failed to conceive.
(4) Now deceased

Table 4 lists the proposed "next round" of pairings if the current pairings do not produce any young by mid-February. Mid-February is chosen as the time for reorganising pairings as it will be 3 months since the current pairings were made. An examination of the 6 pregnancies achieved in the colony showed that young were conceived on average about 20 days after their parents were paired, with the longest time before conception being 42 days. Leaving the animals together for three months would therefore allow for both the longest time to conception and the 38 day gestation period.

Table 4: Proposed pairings if none of the current pairings produce young by mid-February. #4 and #10 are not included because #4 is not generally being considered in the breeding program owing to her age and history of aggression from males, and #10 has pouch young. It may be desirable to try #4 with #28 (the only available male that she has not already been paired with unsuccessfully) although he may be her grandson.

Female #	**Preferred mates**	**Already tried**	**Next choice**	**Notes**
#1	#3, #6, #7, #11, #28 (but see notes to Table 3)	#3, & #7 (no young) #6 (one young only in 1995)	#11	#11 is preferred because although he is part of the #10 lineage, he was wild born and therefore has additional genetic material from his father.
#18	#3, #7, #11, #28	#7 (no py), #11 (current)	#3	Will unfortunately link young to the #10 lineage (ie same father)
#19	#7, #6	#6, #7 no py with either	#6 again	If fails again will have no choice but to pair with half brother #11
#27	#3, #6, #7, #11, #28	#3, #7	#6	

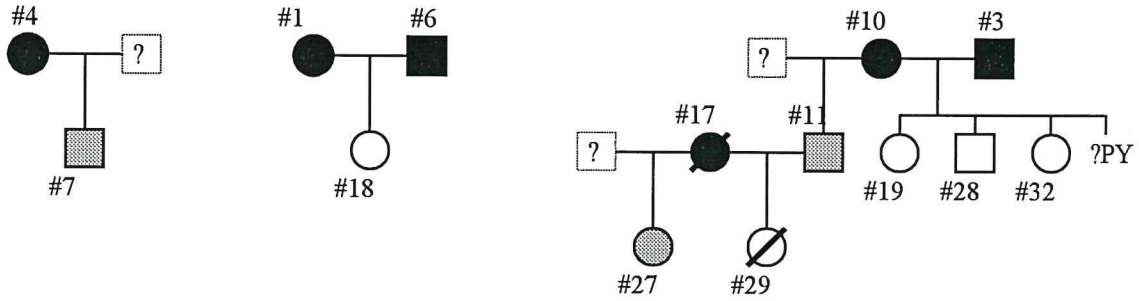
It is difficult to determine the reasons for the failure of females to conceive. Possible reasons include dietary inadequacy or stress leading to females not cycling, or behavioural factors such as incompatibility, inappropriate housing arrangements or dominance hierarchies. The fact that #10 and #3 produce young immediately they are housed together, and yet both can be housed with other partners for several months without conceiving suggests that behavioural factors are at least partly responsible. Further work on the social organisation of the wild populations perhaps involving a combination of spooling, radio-tracking and genetics may also shed light on this question.

A behavioural study of the captive colony was conducted in November 1997 by Kylie Burke as part of an Edith Cowan University Honours project. Four cages were video taped for a 16 hour period every day for four weeks. The four cages included in the study housed a lone male (#28), a male/female pair (#11 and #18), a male with two young adult females (#7 with #19 and #27) and a male/female pair with their juvenile young (#3, #10 and #32). #10 conceived during the period of the study so there is video taped evidence of the behaviour of a compatible pairing although it is not clear yet whether completed matings have been recorded (the camera only covers the $9m^2$ cleared area around the feeding area at the front of the pens). A complete behavioural catalogue of all observed behaviours has been drawn up and analysis of all behaviour (divided into 9 broad behavioural categories) is currently underway. It is hoped that the behavioural analysis will be able to identify differences in the behaviour of compatible versus non-compatible pairings. The thesis is due to be submitted on February 20th, 1998.

If behavioural incompatibility is the cause of animals failing to reproduce, several individuals are running out of potential unrelated partners. For example #19 has been paired with both #7 and #6, and has not produced young with either of them. All of the remaining males in the colony are her first degree relatives (father #3, brother #28 and half-brother #11). This means that either attempts to breed from this female will have to be discontinued, or she will have to be paired with related males.

Because reproduction is currently confined to one breeding pair, the genetic structure of the colony is becoming increasingly dominated by one lineage. Figure 1 summarises the known relationships of all animals currently in colony. It is also possible that the four animals from Hakea (#1, #3, #4 and #7) are all part of the same family, with #1 and #3 (as well as #7) possibly being the young of #4. Studies of mtDNA which is inherited through the maternal line may be able to resolve this question.

Figure 1: Known relationships of Gilbert's Potoroos in the captive colony. Key: Circle=Female, Square=Male, Solid black=Founder animal, Grey=mother known, father unknown wild, White=captive born, both parents known. Incomplete squares with question mark are unknown fathers of wild born young. Line through=animal deceased.



Apart from behavioural factors, the low reproduction rate could be due to either the females failing to cycle or the males failing to produce viable sperm. Kevin Ellard from Wildlife Veterinary Services has applied for WWF and Cheryl Edwardes Community Conservation Grants to conduct a preliminary oestrus cycle study to ensure that all the females are in fact cycling. The initial stages of the study will primarily involve investigating techniques which will enable regular samples to be collected from the animals with minimum disturbance (for example using faecal or urine samples collected in trays around the feeding bowls). As discussed in section 3.2, diet may also be a factor in limiting reproduction and it is hoped that the proposed dietary study described in the diet section (3.2) will assist in improving reproductive output in the colony.

5.4 Husbandry of the colony

5.4.1 General Husbandry

Husbandry is becoming an increasingly time consuming aspect of the program with 12 animals to care for and improvements in husbandry methods being implemented on a regular basis. For example, the inability to rest cages to allow for the break down of food scraps and faecal material, and the fact that the cages are housing on average 1.5 animals each has resulted in the need to regularly rake the cages to bury the surface material and to completely replace the substrate more frequently. In addition, mushroom farms have been acquired to enable the freshest possible mushrooms to be included in the diet. The combined actions of feeding, shopping, cleaning the facility, handling, veterinary aspects, maintaining SPARKS and researching and writing captive management and husbandry plans now accounts for well over 50% of the workload of the project.

Regular fortnightly handlings of all animals (except those with pouch young) was continued through 1997 and has provided useful information on growth of young, tooth eruption sequences (which will assist in estimating ages of wild caught animals) and normal weight fluctuations. Animals are caught and cloacal swabs taken as a precautionary measure any time diarrhoea is found in the cages. In all cases the resulting cultures have been normal, and the diarrhoea was probably caused by minor dietary changes (such as introducing a new food). Animals are also video taped on the first night or two following a new pairing or grouping to ensure that no severe aggression or exclusion of an animal from the feeding area is occurring.

The mouse problem in the captive facility appears to have been completely resolved. Only three mice were caught in the pens in 1997. All three were caught over a two day period in May and none have been caught before or since. In addition, over three months of video taping of four of the pens, no mice were seen in any of the cages even though the cameras were covering the open area near the food bowls and were recording all night. This suggests that there are in fact *no mice* in the cages rather than a non-trappable population.

A revised Husbandry manual is in preparation incorporating the various changes, and a draft paper on husbandry methods has been prepared and is being revised in the light of co-authors comments prior to submission (See list of reports and publications at the end of this report).

5.4.2 Veterinary Care

On 23rd March 1997 blood samples (of varying volumes) were collected by Kevin Ellard from 7 of the captive animals to test for renal function following the death of Female #17 with renal problems. Without established "normals" the results are difficult to interpret, however the values obtained fell within the range of values for domestic animals. An attempt was made to collect blood from the animals at East Firebreak to obtain "normal" values from wild animals, however, no samples of sufficient size were obtained. Blood samples from wild caught animals will be obtained when possible to establish these values.

In early 1997 one of the males was noted to have a pustule on the cloaca. The vet was called and on examination the penis was found to be thickly encrusted with sand, and there was some inflammation and possible infection. All other males were then checked to determine if the condition was widespread in the population or was unique to that male. All males were checked and swabs taken for culture. A range of bacteria and a possible spirochaete were isolated from the swabs. Several females, including a virgin female, were also swabbed and found to have a similar range of bacteria present. Trapping was also carried out at East Firebreak to determine whether a similar condition was occurring in the wild population. Three males were caught at East Firebreak and a further male was caught during later trapping efforts at Hakea Gully. The results revealed a similar condition in the wild males, and the cultures from the swabs returned similar bacterial populations. All males have been checked routinely ever since and the condition has been found to be almost universally present, and certainly occurs in all males at some time. Males housed alone appear to be the worst affected. Males with females also have various degrees of encrustation at various times, and the condition was present at the time the last two young were conceived. No further suggestion of infection has been noted in any animal, and the condition appears to be normal for this species. The inclusion of a single male in the recent behavioural study was intended to determine whether lone males are engaging in any activity (for example excessive scent marking) which could be exacerbating the condition in these individuals.

Veterinary services have been utilised on a number of occasions throughout 1997 to conduct autopsies on dead animals, assist in collecting blood specimens, analyse cloacal swabs (in connection with both diarrhoea and the "sandy penis" syndrome), and conduct other analyses as required (for example analysing the diet for oxalate, blood samples to establish renal function etc). Some of the work was supplied for free, or conducted by the vets in their own time. This arrangement is undesirable for a number of reasons, not least because it limits the availability of veterinary services to times when the vets are not involved in other work. One possible solution is to buy a block of veterinary time which would enable any work on the potoroo to be treated as a priority within the vet's works program. Quotations on the cost of buying a block of time revealed that a minimum of $2000 needs to be set aside for "time" which would buy about 5 days of veterinary time for the year. Laboratory costs would be additional to the

time component and, based on the analyses done in 1997, a further $2000 would be required to cover bacteriological cultures, histology, autopsies, nutritional analyses and some contingency money to cover any unexpected tests that may be required.

5.5 Additional Housing

Plans are underway to extend the pens by up to 6 cages (depending upon costs and availability of labour) in early 1998. Quotes have been obtained from the Albany Prison to prefabricate the modules for the cages and availability of labour from within CALM to construct the pens is being organised. The construction has unfortunately been delayed owing to the need to leave the animals undisturbed during the period of the behavioural study (which itself was delayed by problems obtaining equipment, especially the glass for the red lights), and by the severe fire season being experienced in the south west which has limited the availability of staff for construction.

6. GENETIC/TAXONOMIC STUDIES

Genetic/taxonomic studies are not included in the IRP, however they are listed as a scope item in the Project specifications and have been written into the draft Recovery Plan. All the genetic studies have been carried out by Elizabeth Sinclair and were funded through her PhD grant from ALCOA. A detailed report on the genetics (provided by Elizabeth Sinclair) is included as Appendix 1 to this report.

Morphological studies have not been progressed any further. Several days is required in the WAM in Perth examining specimens and the demands of colony husbandry, student supervision and field work have so far made it impossible to find the block of time away that is required. A few days has been scheduled to complete this work during winter 1998.

7. HUMAN RESOURCES

Owing to ill health, Jackie Courtenay was employed at 0.6 FTE between January 1st and September 30th, 1998. She returned to full time work as of October 1st. Sarah Vetten was employed at 0.5 FTE between February and June 1997. Sarah completed her work towards the end of June and chose to return to Perth although the offer was made for her to continue in the position. The Technical Officer position was advertised at the end of October and interviews conducted on December 5th. A recommendation for the appointment was made by the selection committee on January 15th. It is therefore unlikely that the Technical Officer will begin work on the project before March 1998.

8. EDUCATION, PUBLICITY AND SPONSORSHIP

8.1 Media

- Interview on local ABC radio with Sue Mercer about the Potoroo program was broadcast live in January 1997

- An article on the Potoroo program by Lyndall Whyte appeared in the Weekender (the local free weekly newspaper in Albany) on 16th January, 1997

- An article on the Potoroo program by Caryn Coatney appeared in the Albany Advertiser on March 6th, 1997

- Caryn Coatney also prepared an article on the Potoroos for the Christian Science Monitor while their photographer was in Albany in March. It is not known whether the article was ever published

- A new item on the Gilbert's Potoroo project was broadcast on GWN on June 2nd 1997.

- The presenter and film crew from Channel 10's "Totally Wild" spent two days at Two Peoples Bay on 24th and 25th September. They ended up obtaining footage for three stories: the Potoroo, a general story on the Two Peoples Bay monitoring transect trapping and a story on a Mardo (*Antechinus flavipes*) that was caught during the monitoring. All three are due to go to air in early 1998.

8.2 Talks

- Lunchtime talk to the Albany Over 50's group on July 29th. The talk was reported in the Healthways Over 50's newsletter.

8.3 Project and Work Experience students

- Kylie Burke (Biology Honours, Edith Cowan University) spent several months at Two Peoples Bay conducting a study on the reproductive behaviour of Gilbert's Potoroo using all night video tapes. The first few three months was spent organising equipment and developing a full catalogue of behaviour. The

intensive study was carried out over a one month period. Her thesis is due to be submitted on February 20th, 1998.

- Sarah Kivell (3rd year Environmental Management, ECU) spent a week at Two Peoples Bay in September assisting with trapping along the Mt. Gardner annual monitoring transect. A report was produced for her third year project and was received in November 1997.
- Several work experience and university practicum students also assisted with aspects of the Potoroo project in 1997. These included Rebecca Thieke (High School work experience Mt. Barker) and tertiary students Scott Brook (Queensland), Janine Rogers (Melbourne), Rob Razzi (Melbourne) and Paul Evans (Edith Cowan University, Perth).

8.4 Volunteers

Several people assisted with various aspects of the Potoroo project during 1997. Lawrence Cuthbert donated a week of his time to do a considerable amount of finishing work in the prep. room including sealing the floors and preparing the walls for painting and some general maintenance on pen doors etc. Other volunteers who assisted in the field program were Jacqui Lund, Nic Power, Annette Carroll and David Ende.

8.5 Publications and Reports

The following reports and publications were prepared by Jackie Courtenay, unless otherwise indicated.

8.5.1 Unpublished reports

Unpublished Annual Report to Environment Australia (with Kelly Gillen): "Gilbert's Potoroo Recovery Program Annual Report, 1996" (submitted January 1997)

Unpublished Report for the Gilbert's Potoroo Recovery Team entitled "Report on the Death of Female #17" March 1997

Unpublished Report for the Gilbert's Potoroo Recovery Team entitled "Report on the Death of Female #29" April 1997

Unpublished report for the Gilbert's Potoroo Recovery Team entitled "Report on the health and breeding success in captive Gilbert's Potoroos (*Potorous gilbertii)*" April 1997

Unpublished progress report to Edith Cowan University "Post-Doctoral Research Project - Ecology and Management of Gilbert's Potoroo (*Potorous gilbertii*): Progress report on the 6 months October 1996-March 1997".

Unpublished progress report to Environment Australia: Gilbert's Potoroo Recovery Program Progress Report, August 1997

Unpublished progress report to Edith Cowan University "Post-Doctoral Research Project - Ecology and Management of Gilbert's Potoroo (*Potorous gilbertii*): Progress report on the 6 months April 1997-September 1997".

8.5.2 Publications

Gillen, K., Danks, A., Courtenay, J and Hickman, E. 1997 Threatened species management on the south coast of Western Australia *PARKS* (Journal of the IUCN Protected Areas Program) 7(1):23-30

Sinclair, E.A. and Courtenay, J. (submitted) The ecology of Gilbert's Potoroo Ch 19 in Angas Hopkins and Graeme Smith (eds) *The Natural History of Two Peoples Bay*

Courtenay, J., Danks, A., Manson, W., Start, A. and Whisson, L. Status and husbandry of the newly rediscovered Gilbert's Potoroo *Potorous gilbertii*, Gould 1841 (Macropodoidea: Potoroidae). A complete draft of this paper was circulated to co-authors in July and is now being revised in accordance with their comments.

8.5.3 Recovery Plan

A complete draft of a Recovery Plan for Gilbert's Potoroo was completed by Jackie Courtenay and circulated by the chair of the recovery team to co-authors Tony Start and Andrew Burbidge and other Recovery Team members in October 1997.

8.5.3 Monthly Reports

Monthly summary reports on captive colony and field work were implemented in April 1997. These reports provide a basic summary of the status of the colony and major field work activities.

8.5.4 Conference Presentations

The following spoken paper was presented by Sarah Vetten at the Australian Mammal Society Conference in Clare, SA in July 1997.

Vetten, S., Courtenay, J., and Needham, A. Microhabitat use in Gilbert's Potoroo in relation to vegetation associations and ground cover.

8.6 Sponsorship

Limited sponsorship was obtained for several aspects of the project in 1997. SONY (Perth) loaned a video and quad splitter for several months for the behavioural study. Archie Martin Vox (Albany) gave a 20% discount on all videos purchased for use in the behavioural study. Telstar Electricals (Albany) provided a discount on the hire of a video and TV screen for analysis of the videos. Jassi Skincraft donated a small quantity of sheepskin to trial sheepskin lining of radio collars.

References

Asa, C. 1996 Reproductive Physiology Ch 37 in D.G.Kleiman, M.E. Allen, K.V. Thompson & Lumpkin, S. *Wild Mammals in Captivity: Principles and Techniques.* University of Chicago Press, Chicago, USA.

Courtenay, J. 1997 "Report on the Death of Female #29" Unpublished Report to the Gilbert's Potoroo Recovery Team, April 1997

Courtenay, J., Start, A., & Burbidge, A.A (in prep) Recovery Plan for Gilbert's Potoroo (*Potorous gilbertii*)

Start, Tony & Burbidge, Andrew. 1995 Interim wildlife Management Guidelines for Gilbert's Potoroo (*Potorous tridactylus gilbertii*)

Vetten, S. 1997 1996 Microhabitat use in Gilbert's Potoroo in relation to vegetation associations and ground cover. Unpublished Honours thesis, Dept of Applied Science, Edith Cowan University.

Report on genetic work in 1997
Liz Sinclair (January 1998)

Introduction and aims

Genetic studies of declining populations can provide information on population substructure and gene flow within or between populations, and may therefore be crucial for future conservation strategies (Petrie *et al.* 1997). Small, isolated populations are known to lose genetic variation rapidly (Allendorf 1986), and Frankham (1996) provides empirical support for conservation concerns regarding small fragmented populations. Populations that have recently suffered a severe reduction in size are especially important to identify for conservation, because they may suffer an increased risk of extinction (Cornuet and Luikart 1996). The longer these populations remain isolated, the greater the loss of variation and increase in chance extinction through stochastic events.

At present, *P. gilbertii* is known from a single population in the Two Peoples Bay Nature Reserve. Trapping data suggest that there may be some spatial structuring within *P. gilbertii*. Animals are usually trapped and retrapped within small localized areas, suggesting that a number of animals have overlapping home ranges, and that the groups are relatively stable. Through a detailed analysis of fine-scale genetic structure and estimation of relatedness among individuals, using microsatellite (nuclear) DNA markers, it will be possible to determine if there is genetic subdivision, that is, whether the four local subpopulations (Hakea, Robinsons, north and east Firebreak) reflect breeding groups as well as social groups. Levels of variation were also compared between the captive and wild populations of *P. gilbertii*, to see whether the captive population adequately reflected variation in the wild.

Results and Discussion

The microsatellite markers (loci) were not particularly polymorphic, making it difficult to assess paternity for the wild population. There was no evidence of a genetic bottleneck in *P. gilbertii*. This is consistent with little or no loss of genetic variation. Estimates of effective population size were an order of magnitude greater than the known population. This is surprising, given the impact that fragmentation and predation has probably had, and that the population size cannot be very large. As this estimate is based on heterozygosity levels, which were relatively high, the estimate of Ne may reflect an estimate of the effective population size prior the demographic decline. As yet, there is no evidence to support a genetic bottleneck in these markers.

This absence of evidence for a bottleneck may be explained in several ways. =46irstly, the low number of microsatellite loci (six) and individuals (21) may have invalidated the bottleneck test, as generally a minimum of ten individuals and twenty polymorphic loci are required. However, a significant result was obtained for the captive colony of long-footed potoroos (*P. longipes*) which is known to have been through a demographic and genetic bottleneck, indicating that the test could still be applied to small data sets. Secondly, *P. gilbertii* may have been through a very recent population decline, in which there was no sign in the nuclear loci as yet. The effects of such a recent bottleneck would then be more likely to be observed in mitochondrial DNA. Thirdly, a bottleneck may have occurred far enough in the past that the small population has had time to reach a new mutation-drift equilibrium and hence evidence for a past bottleneck would not be observed using this analysis. However, this is unlikely as the effects of a bottleneck take a long time to erase (Nei *et al.* 1975). Finally, the population of *P. gilbertii* may not be as small as thought. Fossil and subfossil material, and anecdotal evidence all suggest that *P. gilbertii* was more abundant and widespread than at present (Cook 1963; Merrilees 1968; Baynes et al. 1975), although it does seem unlikely that there would be large numbers of animals that have not even been detected. The Two Peoples Bay Nature Reserve has never been totally isolated. It is still linked to Mt Manypeaks Nature Reserve to the northeast through a habitat corridor, but it is unknown whether animals would move through this area or occur in the Mt Manypeaks Nature Reserve. It is more likely that this *P. gilbertii* population has been small for a long time, rather than have recently suffered a bottleneck. It is at the eastern edge of the high rainfall area in the southwest. All other known records are further west from Two Peoples Bay. However, the wild population at Two Peoples Bay is, or has probably been, larger than is presently known.

Significant genetic subdivision in the wild population of *P. gilbertii* (Rho =3D 0.121, p =3D 0.008) suggests that there is low gene flow between th=e four subpopulations. There was no significant subdivision detected within either sex, thus providing no evidence for differential movement of one sex over the other. Although the animals are probably capable of moving over the distances between the subpopulations under certain circumstances, the genetic data suggest that this is not breeding behaviour. Mean pair wise relatedness estimates among individuals within each of the four subpopulations were higher than for among subpopulations. The estimates for samples at Hakea and Robinsons Gully were very high (mean =B1 SE: 0.481 = =B1 0.087, 0.533 =B1 0.0111, respectively) and equivalent to a parent-offspring relationship. Relatedness estimates within north and east Firebreak subpopulations were considerably lower (0.118 =B1 0.156, 0.169 =B1 0.0175, respectively) as they contained apparently unrelated individuals. A relatedness estimate of -0.051 =B1 0.096 among all four subpopulations is close to zero, indicating that the population as a whole is not inbred. Neither males nor females were significantly more related to each other within, relative to among subpopulations. There is no documented evidence of dispersal by either sex. Significant genetic subdivision is also supported by field observations (Vetton 1996; Jackie Courtenay, pers. comm.).

Social structure has been examined in two potoroo species. Long-footed potoroos (*P. longipes*) were found to have overlapping home ranges with their respective mates (or sub-adult offspring) only, and no difference was observed in range size between males and females (Scotts and Seebeck 1989). Seebeck *et al.* (1989) concluded that this species is territorial and monogamous. For both subspecies of long-nosed potoroo (*P. tridactylus*), animals had overlapping ranges for males and females, but with male ranges being larger than female ranges (Kitchener 1973; Bennett 1987). The situation in *P. gilbertii* appears similar to that observed in *P. tridactylus*. From observations in the captive colony though, some pairs of adults are more successful breeders than others, so it may be that there is mate preference, perhaps more like the monogamy observed in *P. longipes*.

The captive colony is represented by individuals from three of the four wild subpopulations, and allele frequencies between wild and the captive populations were similar. However, maintenance of variation in the wild may have occurred through fine-scale heterogeneity. Maintaining the subpopulation lineages in captivity may help prevent loss of variation from the captive population. Although this may not be possible where pairs are incompatible. However, in the short-term it will be more important to increase the total number of animals, rather than be concerned with the longer term genetic consequences. =46uture research Evidence from mitochondrial DNA may provide further information on whether there has been a bottleneck, and mechanisms for the maintenance of subdivision at such a fine-scale. Sequencing of the mtDNA from 403 bp of control region from three individuals suggest that there may be little variation in *P. gilbertii* (E. Sinclair, unpublished data). As the mitochondrial molecule is much more prone to showing the effects of a bottleneck, this may shed light on whether there has been a significant demographic decline in *P. gilbertii* or that the population at Two Peoples Bay is part of a larger, as yet unknown, population (or species range). It is predicted that if *P. gilbertii* has been forced through a severe and extended bottleneck, then few mitochondrial haplotypes will be detected.

References

Allendorf, F.W. (1986). Genetic drift and the loss of alleles versus heterozygosity. Zoo Biology 5: 181-190.

Baynes, A., Merrilees, D. and Porter, J.K. (1975). Mammal remains from the upper levels of a late Pleistocene deposit in Devil's Lair, Western Australia. Journal of the Royal Society of Western Australia 58: 97-117.

Bennett, A.F. (1987). Conservation of mammals within a fragmented forest environment: The contributions of insular biogeography and autecology. In Nature conservation: The role of remnants of native vegetation (eds. Saunders, D., Arnold, G., Hopkins, A. and Burbidge, A.) (Surrey Beatty, Sydney). pp. 41-52.

Cook, D.L. (1963). The fossil vertebrate fauna of Strongs Cave, Boranup, Western Australia. Western Australian Naturalist 8: 153-162.

Cornuet, J.M. and Luikart, G. (1996). Descriptions and power analysis of two tests for detecting recent population bottlenecks from allele frequency data. Genetics 144: 2001-2014. =46rankham, R. (1996). Relationship of genetic variation to population size in wildlife. Conservation Biology 10: 1500-1508.

Kitchener, D.J. (1973). Notes on the home range and movement in two small macropods, the potoroo (*Potorous apicalis*) and the Quokka (*Setonix brachyurus*). Mammalia 37: 231-239.

Merrilees, D. (1968). Man the destroyer: late Quaternary changes in the Australian marsupial fauna. Journal of the Royal Society of Western Australia 51: 1-24.

Nei, M., Maruyama, T. and Chakraborty, R. (1975). The bottleneck effect and genetic variability in populations. Evolution 29: 1-10.

Petri, B., P=E4=E4bo, S., von Haeseler, A. and Tautz, D. (1997). Paternity assessment and population subdivision in a natural population of the larger mouse-eared bat *Myotis myotis*. Molecular Ecology 6: 235-242.

Scotts, D.J. and Seebeck, J.H. (1989). Ecology of *Potorous longipes* (Marsupialia: Macropodidae): with preliminary recommendations for its conservation in Victoria. (Arthur Rylah Institute of Environmental Research, Victoria).

Seebeck, J.H., Bennett, A.F. and Scotts, D.J. (1989). Ecology of the Potoroidae - A Review. In Kangaroos, Wallabies and Rat-kangaroos (eds. Grigg, G., Jarman, P. and Hume, I.) (Surrey Beatty, Sydney). pp. 67-88.

Start, A.N. and Burbidge, A.A. (1994). Interim wildlife management guidelines for Gilbert's potoroo (Department of Conservation and Land Management, Perth)

Vetten, S. (1996). Microhabitat use by Gilbert's Potoroo (*Potorous tridactylus gilbertii* Gould) in relation to vegetation associations and ground cover. (Honours thesis, Edith Cowan University).