Rangelands Restoration: Fauna recovery at Lorna Glen, Western Australia

Progress Report August 2008 – June 2010

Prepared by Emily Miller, Judy Dunlop and Keith Morris

Department of Environment and Conservation, Western Australia

Science Division, Woodvale

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Introduction

Operation Rangelands Restoration commenced following the acquisition of the Lorna Glen and Earaheedy pastoral leases by the Western Australian (WA) Government in 2000. This 600,000ha area lies across the boundary of the Gascoyne and Murchison IBRA regions is now the site for an ecologically integrated project to restore rangeland natural ecosystem function and biodiversity. An important component of this project is the reintroduction of 12 arid zone mammal species following the successful control of feral cats and foxes (Morris *et a*l. 2007).

The area now comprising Lorna Glen once supported a diverse mammal fauna that was representative of the rangelands and deserts to the north and east. These areas have suffered the greatest in terms of mammal declines in WA (Burbidge and McKenzie 1989). Potentially Lorna Glen could support one of the most diverse mammal assemblages in arid Australia, and contribute significantly to the long-term conservation of several threatened species. Mammal reconstruction in this area will contribute significantly to the restoration of rangeland ecosystems through activities such as digging the soil and grazing/browsing of vegetation, as well as assist in the return of fire regimes that are more beneficial to the maintenance of biodiversity in the arid zone. Once populations have established, there will be considerable potential for students and other researchers to study arid zone mammal biology, ecology and related issues.

The mammal reintroductions at Lorna Glen commenced in August 2007. This report updates these activities at Lorna Glen from August 2008 to June 2010 from that written by Morris and Dunlop (2008).

1. Predator Control

Since 2004, feral predators have been controlled through trapping, aerial baiting and more recently fencing. These strategies have been successful and maintained cat activity at less than 10 tracks per 100 linear kilometres (Dave Algar *pers comm*.).

1.1 Trapping

A strategic cat trapping program was implemented following animal releases as part of the active adaptive management control strategy. The trapping program used an elevated trap design that eliminated the risk of capturing bilbies and other native mammals in leg hold traps. Since brushtail possums are more adept to climbing, leg hold traps are currently not set in areas of *Eucalyptus camaldulensis* woodlands. Trials of a "possum proof trap" are ongoing.

1.2 Aerial Baiting

Aerial 1080 baiting (50 Eradicat baits / square kilometre) is not only useful in reducing feral cats, but also foxes, dingoes and wild dog abundance. Aerial baits are dropped in the coldest months (June/July) as bait uptake is greatest in the arid zone when the abundance and activity of all prey types, in particular predator-vulnerable young mammalian prey and reptiles, is at its lowest (Dave Algar *pers comm*.).

1.3 Fencing

The construction of a 15 kilometre cat and fox proof fence was completed in November 2009. The fence was constructed in a triangle, west of and including #10 Well (Fig. 1a - 1c). The top two wires of the fence are electrified and a 30cm skirt is buried underground. This design is the same (except 30cm taller) as that which is used for the Peron Captive Breeding Centre and this has not been breached by cats or foxes in approximately 10 years of operation. The extra height was added at Lorna Glen due to the occasional presence of camels. Within the enclosure, cats were eradicated using a combination of 1080 baits and trapping. Rabbits inhabiting unused boodie warrens were removed using one shot oats, and varanids were reduced via noosing and trapping. All but three red kangaroos within the enclosure have been culled. Prior to animal release, the tracks around the perimeter and through the centre of the enclosure were monitored daily to ensure the enclosure is free of feral cats, rabbits, and wild dogs. Currently, the perimeter of the enclosure, both internally and externally, is monitored every six weeks for signs

(tracks, scats and diggings) of both introduced and native species and condition of the fence.

There are several direct benefits from the construction of this predator proof enclosure. The enclosure:

- Removes the feral cat predation pressure from reintroduced species;
- Provides reintroduced animals with a safer environment to acclimatise to their new habitat;
- Provides resources to reduce deaths attributable to lack of resources;
- Allows closer monitoring of released animals, including a scientific assessment of the role of parasite burden on both the survival and body condition of translocated fauna (Judy Dunlop, PhD project).

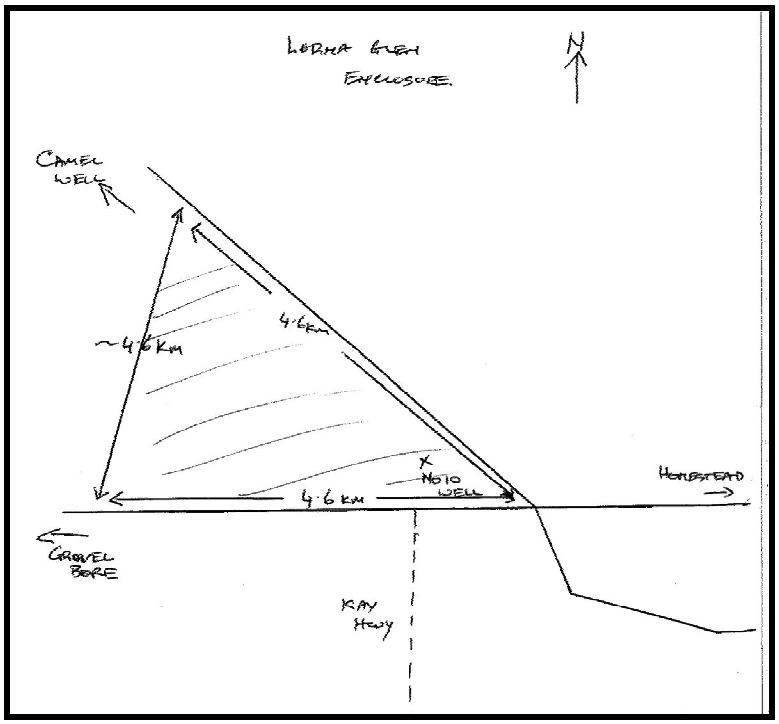

Fig 1a. A schematic diagram of the predator proof enclosure constructed at Lorna Glen.

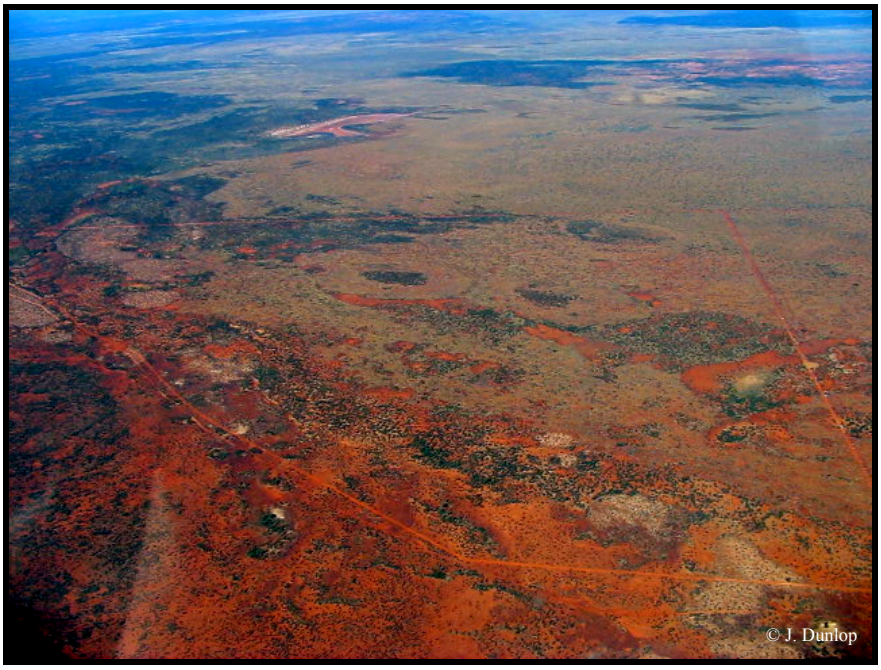

Fig 1b. Aerial view of the enclosure (looking south), showing the habitat diversity within the area.

Fig 1c. A male red kangaroo outside of the predator proof enclosure at Lorna Glen.

1.4 Non-toxic Cat Bait Trials

Trials using non-toxic Eradicat feral cat baits were conducted within the fenced enclosure during May 2010 to examine the frequency and quantity of bait uptake by non-target species, in particular boodies (*Bettongia lesueur*) and golden bandicoots (*Isoodon auratus barrowensis*). Three transects (*n* = 8 each) were established in the enclosure and one bait (15g dry weight) was placed on the each sand pad for five consecutive nights. Of the total 110 baits laid, 29 were taken (23 whole; 6 partial); 68 were visited (but not taken) and 13 had no visits. The species taking and visiting the baits is shown in Figure 2.

Boodies have a high tolerance to sodium monofluoroacetate (1080 poison). Animals tested survived doses of up to 10-20 mg/kg of 1080 (King *et al.* 1981, McIlroy 1982), suggesting that boodies should be at little risk from accidental poisoning during fox, cat, and rabbit control programs. An average sized (1.5kg) boodie would need to eat five Eradicat baits to have a 50% chance of being killed.

Although the species *Isoodon auratus* has not been tested for 1080 susceptibility, other species of bandicoots have been shown to have a high tolerance to the poison. On average, the bandicoot group has LD50s ranging between 5.9 and 13.2 mg/kg (Twigg *et al.* 1989, McIlroy 1992) and the eastern states southern brown bandicoot *I. obesulus* have an LD50 of 7 mg/kg. From these calculations, an average sized golden bandicoot would need to eat 1-2 Eradicat baits to have a 50% chance of lethal dose. Generally, animals from Western Australia have higher tolerance for 1080 than those listed for Eastern states, due to the increased presence of the 1080 toxin in the WA environment. There is some concern regarding the low number of baits that may be required for a potentially lethal dose in golden bandicoots due to their small size (200 – 600g). A 1080 anticipated lethal dose (ALD) trial is being proposed.

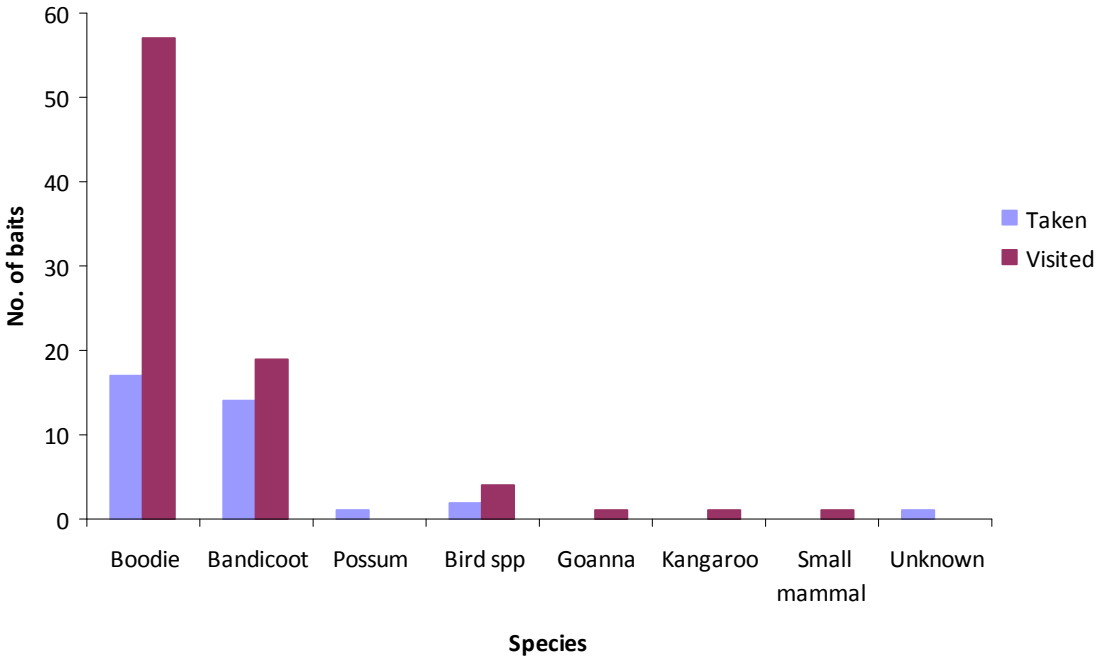

Fig 2. Summary of the species in the enclosure taking and visiting the non-toxic Eradicat cat baits.

2. Mammal Reintroduction Program

Operation Rangelands Restoration proposes that 12 mammal species be reintroduced to Lorna Glen over a seven year period (2007-2013). To date, five species have been reintroduced: the greater bilby (*Macrotis lagotis*), brushtail possum (*Trichosurus vulpecula*), mala (*Lagorchestes hirsutus*), boodie (*Bettongia lesueur*) and golden bandicoot (*Isoodon auratus*). Table 1 summarises for each species, their origin (source population), release date, sex and total number of individuals released.

Table 1. Summary of the mammal translocations at Lorna Glen 2007- 2010.

Species	Origin	Date	No. males	No. females	Total
Greater bilby	Thistle Island, SA	Aug 2008	17	15	32
	RTD*	Aug 2007	14	11	25
	PCBC#	Aug 2007	12	9	21
	RTD*	Aug 2008	16	11	27
	PCBC#	Sept 2008	0	1	1
	RTD*	Aug 2009	13	0	13
	PCBC#	Aug 2009	6	5	11
Brushtail possum	RTD*	Aug 2007	5	3	8
	Boyagin	May 2008	11	10	21
	Mt Caroline/ Curtin University	May 2008	6	0	6
	Karakamia	May 2008	22	14	36
	Karakamia	July 2009	12	12	24
Mala	PCBC#	Aug 2008	9	20	29
Boodie	RTD*	Jan 2010	15	5	20
	Barrow Island	Jan/Feb 2010	39	27	66
Golden bandicoot	Barrow Island	Jan/Feb 2010	78	82	160

*_Return to Dryandra_ captive breeding program; #Peron Captive Breeding Colony.

Currently, the reintroduced animals within the enclosure receive supplementary food and water *ad lib.* To survive in the wild, animals need to become skilled at acquiring their own resources therefore food has been gradually reduced since April 2010.

2.1 Animal Release and Site Selection

2.1.1 Greater bilby, *Macrotis lagotis*

To date, a total of 130 bilbies from three source populations have been wild-reintroduced to Lorna Glen (Table 1). New animals were released at sites chosen via dispersal by animals from previous releases. Bilbies were generally released into red sand dune areas, particularly those close to the two large ephemeral lakes on the property, Pink Lake and Possum Lake. These ephemeral areas provided variety of habitats and subsequent associated resources within a small area.

2.1.2 Brushtail possum, *Trichosurus vulpecula*

A total of 95 brushtail possums from four source populations have been wild-reintroduced at Lorna Glen (Table 1). Release sites were in *Eucalyptus camaldulensis* woodlands fringing ephemeral wetlands and watercourses. These included # 2 Well, around the Homestead, Lorna Glen Spring, south of #1 Well and the northern end of Possum Lake. We hypothesise that these deep rooted eucalypts provide not only large numbers of tree hollows as shelter, but also year round access to valuable water resources from both its new leaves and insects living in the trees. A potential student project will be a dietary analysis to confirm this hypothesis. Previous surveys (Morris *et al.* 2007) found that possums had also occupied rocky, breakaway areas at Lorna Glen.

2.1.3 Mala, *Lagorchestes hirsutus*

Twenty nine mala were released into the wild at Possum Lake in September 2008. This site was selected due to the presence of large areas of long unburnt Spinifex which provides good shelter for the diurnal nests and scrapes made and used by mala. The ephemeral lake system provides a good variety of vegetation types, including those which are used by mala (Pearson 1989).

2.1.4 Boodies, *Bettongia lesueur*

A total of 86 boodies from two source populations, Barrow Island and Return To Dryandra (Table 1) were released into the seven known boodie warrens that exist within the predator proof enclosure in February 2010. These founder individuals will remain in the enclosure to

breed, and subsequent generations will be released in the wild. At least 50 old boodie warrens are known on Lorna Glen and ones suitable for wild releases are currently under investigation.

2.1.5 Golden bandicoots, *Isoodon auratus barrowensis*

A total of 160 golden bandicoots from Barrow Island (Table 1) were released into the predator proof enclosure in February 2010. The founder individuals will remain in the enclosure to breed, and subsequent generations will be released in the wild. Suitable locations are currently under investigation.

2.2 Monitoring

2.2.1 Greater bilby, *Macrotis lagotis*

All individuals were micro-chipped prior to release at Lorna Glen. Approximately half of all animals released were fitted with mortality sensing tail-transmitters with a four-month battery life. Where possible, animals were recaptured toward the end of the transmitter's battery life and fitted with new transmitters.

Bilbies generally dispersed to areas of mulga/spinifex habitat with clay soils or red sand dunes next to ephemeral lakes. In hard soils or clay substrate, the bilbies preferred to burrow underneath large trees, presumably utilising the larger root systems to excavate burrows. Males tended to travel further than females, and animals frequently utilised each other's burrows. Over 150 bilby refuges have been recorded since their release. Regular track based monitoring and trapping for bilbies has been conducted in previous release and refuge sites. One male and one female with pouch young were successfully recaptured at Possum Lake in April 2010. There have been no recent signs of bilbies near Pink Lake since November 2009. Fresh bilby tracks were recently observed during dragged track counts outside the enclosure in June 2010, however the subsequent trapping was unsuccessful.

Despite their elusiveness, there is evidence that bilbies are surviving at Lorna Glen in the wild. A new track-based monitoring technique (Moseby *et al.* 2009) will be implemented in July 2010 that will contribute to a long-term national monitoring scheme. Briefly, the area based monitoring collects information on the presence or absence of species in a specific area based on their tracks, scats, diggings and burrows. The method involves walking a 2-hectare area over a 30 minute time frame and recording animal tracks and signs found within the plot on a datasheet or CyberTracker (hand held computer widely used by Indigenous groups). There are several benefits of employing this technique:

- It can be replicated at many sites across the landscape.
- It can be submitted to a National database;
- It is a powerful tool in remote areas where large areas need to be surveyed;
- It will provide an overview of the distribution and abundance of both native and feral animals at Lorna Glen;
- It is suitable for Indigenous groups and students to participate.

2.2.2 Brushtail possum, *Trichosurus vulpecula*

All possums were released with a unique left/right ear tag combination to enable individual identification. Animals were initially monitored on a daily basis, whenever possible. The primary reason for having radio transmitters on animals was to determine cause of mortalities when they occurred. Because of the large numbers of animals with radio transmitters at any one time (up to 40), a “live/dead” fix from a known point near to each animal was often taken, and exact refuge locations were only found approximately once a week, or less often when stable.

Trapping for possum using Sheffield wire cage traps has been conducted in 2009 and 2010. In 2009, animals from the initial 2007 reintroduction were captured. In 2010, possums reintroduced 2007 and 2008 were trapped, including the F2 generation. Animals have been trapped North and South of #2 Well, Possum Lake and around the Homestead.

2.2.3 Mala, *Lagorchestes hirsutus*

Of the 29 mala were released in August 2008, 15 were fitted with mortality sensing radio collars with a 12-month battery life. The last radio collared animal died 17/11/08. There has been no evidence of mala since November 2008 (tracks, scats or trapping).

2.2.4 Boodie, *Bettongia lesueur*

All adult boodies were micro-chipped with an individually identifiable PIT tag. Of the total 86 reintroduced individuals, 25 boodies were fitted with mortality sensing radio collars prior to release, with a battery life of 12 months. Currently, 11 boodies are fitted with radio collars. During the first 12 weeks following release (completed 31 May 2010), these animals were located on a daily basis using hand held equipment which has an approximate range of 1 km when the animal is underground, and a pump up vehicle mounted aerial (6m) which has a range of ca. 3 km when the animal is underground. An aircraft fitted with radio tracking aerials is also available should any animals move beyond the range of the ground equipment. Radio tracking has now been reduced to two to three times per week, and this will continue until November 2010.

Trapping within the enclosure has been undertaken for six nights, every six weeks using Sheffield wire cage traps to monitor animal weight, condition, reproductive status, health and disease status, as well as checking or replacing radio-transmitters. The long-term health and disease status of boodies is being monitored as part of a PhD program (Judy Dunlop) in collaboration with Murdoch University (ARC Linkage Grant). The regular trapping intervals will facilitate an investigation into factors affecting translocation success, which will be able to be extrapolated to other small mammal translocations.

Changes in body weight over time for boodies from RTD and Barrow Island (both males and females) are shown in Fig. 3. Initially, the captive RTD boodies weighed significantly more than the boodies sourced from Barrow Island (males $p = 0.013$; females $p = 0.001$). However, the RTD boodies were above the average weight range for boodies (970-1530g). Therefore, it is not surprising the captive RTD animals suffered weight loss

following their reintroduction at Lorna Glen, however it was not significant (p = 0.218). The Despite their weight loss, the RTD boodies are still within a healthy weight range for boodies. The weight of the Barrow Island boodies has remained stable following their reintroduction to Lorna Glen. The overall condition of the animals trapped has been high. Some animals have patchy fur from fighting, presumably over access to resources (food, water, burrows and mates). The reproductive success of boodies at Lorna Glen has remained consistently high with over 80% of females having a pouch young during each trapping session. In June 2010, one new (F1 generation) boodie was trapped and micro-chipped, as well as two individuals that were too small to microchip.

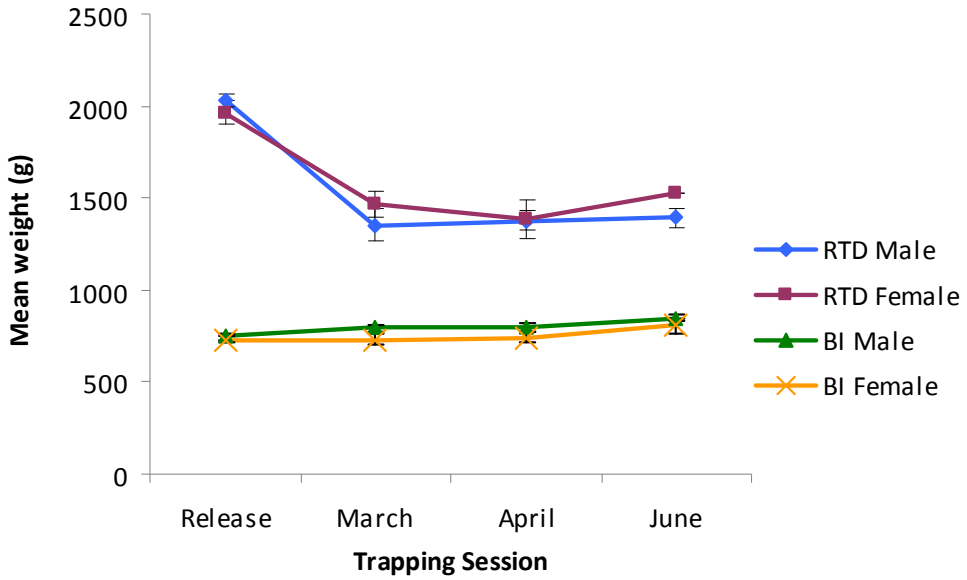

Fig. 3 Changes in body weight (mean ± s.e.) over time for the captive *Return to Dryandra* (RTD) and Barrow Island (BI) boodies reintroduced at Lorna Glen. There is no s.e. for the RTD females in June 2010 as n = 1.

2.2.5 Golden bandicoot, *Isoodon auratus*

All adult bandicoots have an individually identifiable PIT tag. No bandicoots were fitted with mortality sensing radio collars prior to release due to the problems associated with radio collaring small, burrowing animals. The population within the enclosure is instead being

monitoring through regular trapping. Trapping has been undertaken for six nights, every six weeks using Sheffield wire cage traps to monitor animal weight, condition, reproductive status, health and disease status, as well as checking or replacing radio-transmitters. The long-term health and disease status of golden bandicoots is also being monitored as part of a PhD program (Judy Dunlop).

The body weight for both male and female golden bandicoots has fluctuated since their reintroduction to Lorna Glen (Fig. 4). Body weight of both males and females has significantly increased following their initial release, but are still within the weight range for this species (260-655g). Male body weight is gradually increasing, which may reflect the population stabilising, however more data is required to confirm this. The overall condition of the bandicoots trapped has been high. Similar to the boodies, some animals have patchy fur, but no serious injuries. The reproductive success of bandicoots has also remained consistently high with over 85% of females having one to two pouch young present. Since the reintroduction of bandicoots into the enclosure, 11 F1 generation (10M: 1F) have been trapped and micro-chipped.

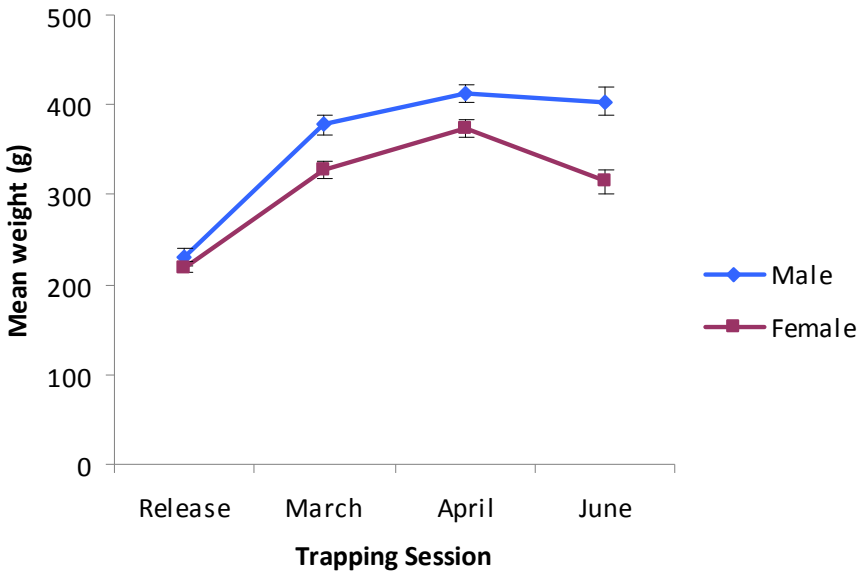

Fig. 4 Changes in body weight (mean ± s.e.) over time for the Barrow Island golden bandicoots reintroduced at Lorna Glen.

2.2.6 Other species

Other species have also been trapped within the enclosure including: mulgara (*Dasycercus cristicauda*), spinifex hopping mice (*Notomys alexis*), and a long-tailed dunnart (*Sminthopsis longicaudata*). Mulgara have also been trapped at Possum Lake and along the Kay Highway in April 2010.

2.3 Mortality

Overall, for bilbies and mala that were wild released in 2007 and 2008, cat predation was the main cause of mortality (Fig. 5). The mortality for each species is discussed below.

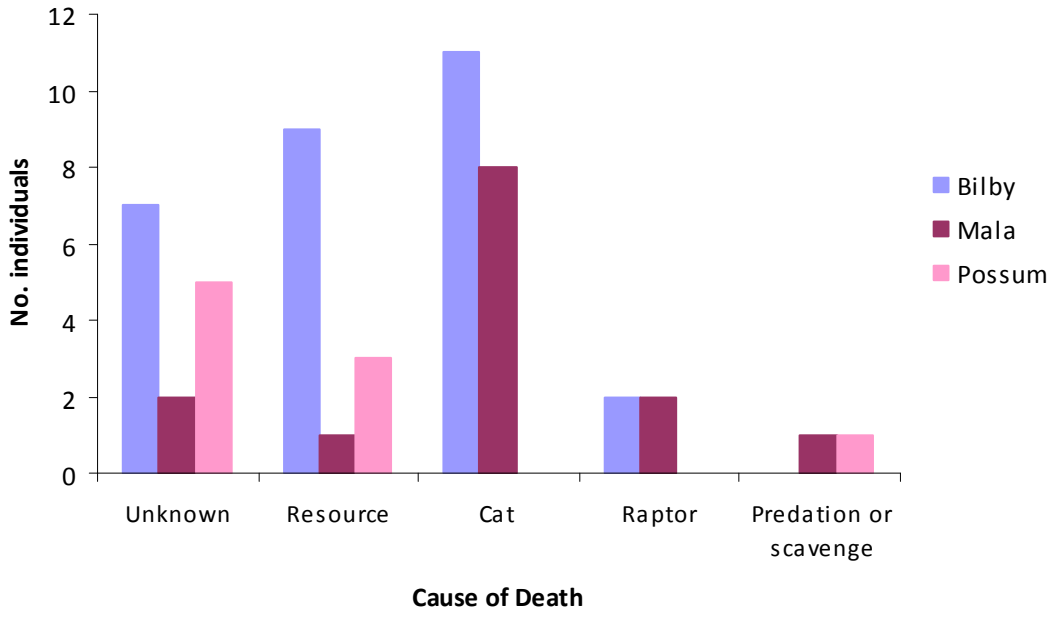

Fig. 5 The causes of mortality for wild released bilbies, mala and possums at Lorna Glen.

2.3.1 Greater bilby, *Macrotis lagotis*

There are interesting trends in mortality that may be related to animal origin. Fig. 6 shows cause of death as a proportion of collared animals based on their origin. Of the known causes of mortality, cat predation was responsible for the highest number of deaths. Captive bred animals (Peron and RTD) suffered the highest levels of predation (cat and raptor) compared to those that were wild born (Thistle Island). These data suggest there may be some level of predator awareness from wild sourced animals, compared to those bred in captivity. A smaller proportion of captive-born animals died due to a lack of resources compared to the wild-born animals, indicating that the captive-born animals were able to forage for themselves despite being provided resources in captivity *ad lib.*

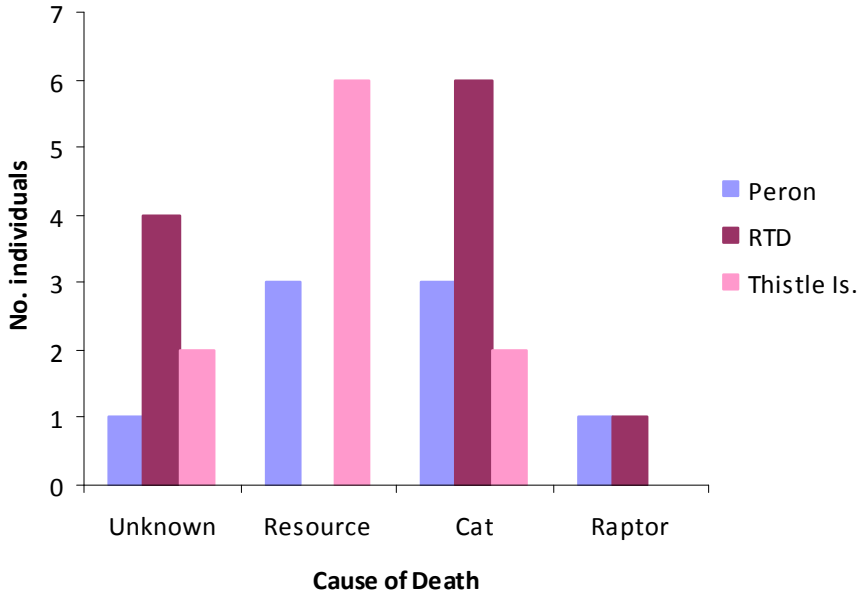

Fig. 6 The causes of mortality for bilbies wild released at Lorna Glen based on their origin.

2.3.2 Brushtail possum, *Trichosurus vulpecula*

Eight radio collared possums are known to have died. The cause of most of these mortalities is unknown. Some were due to a lack of resources and one was a result of raptor predation (Fig. 5). No possums died from cat predation.

2.3.3 Mala, *Lagorchestes hirsutus*

The mala experienced heavy cat predation (55%; Fig. 6). These predation events were consecutive, with one or two animals being killed per night. Cats were observed to be excess killing and caching animals, then returning the following night to consume the carcass. Fig. 7 shows the cumulative mortalities of mala. Seven of the first eight mala deaths were attributed to cat predation. However, these were slowed when two cats were killed at the release site. The following deaths were attributed to native predators (birds of prey or varanids) or resource related deaths.

The main threat to the success of mala reintroductions to Lorna Glen is cat predation. Other factors, such as a poor ability to forage, are likely to have also contributed to the high mortality rates. The reintroduced mala were sourced from an intensive captive breeding facility that did not require them to acquire their own resources, or have predator awareness. Mala reintroductions may benefit from further consideration when selecting a source population, and animal husbandry techniques in captive breeding programs. Furthermore, acclimatisation to the environment within the enclosure is likely to help enhance predator awareness such as varanids and raptors, as well as locating resources in a safe environment.

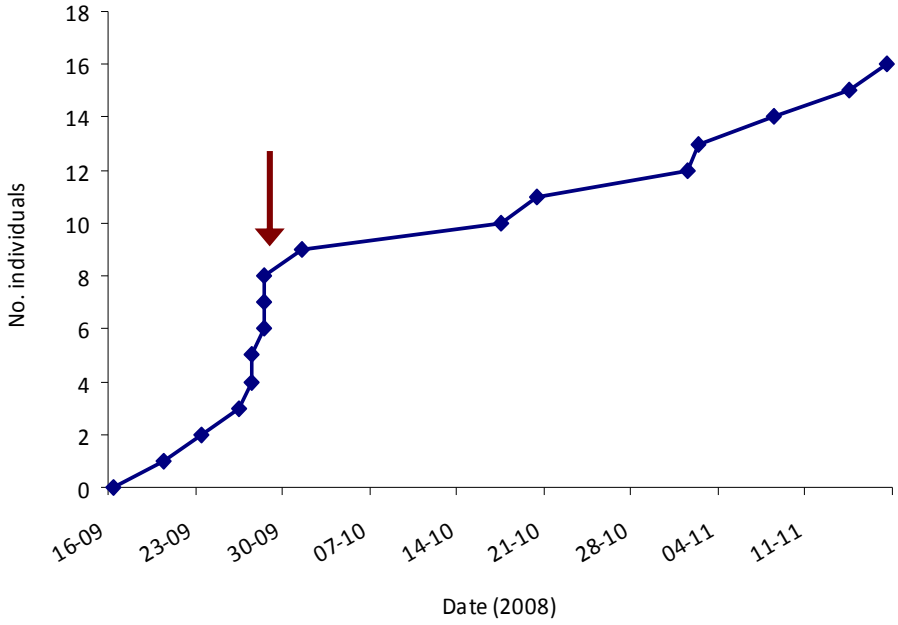

Fig. 7 The cumulative mala mortalites due to cat predation. The arrow indicates when the two cats died.

2.3.4 Boodie, *Bettongia lesueur*

There have been a total of 16 known boodie deaths (RTD *n* = 5; Barrow Island *n* = 9; 2 unknown ID). The majority of deaths have occurred for unknown reasons (Fig. 8), although it is suspected that heat stress contributed to most of them as the animals were found above ground and without shelter. Excluding the two unknown animals, a higher proportion of captive bred animals have died (25%; 5 of 20) compared to the wild caught animals (13.6%; 9 of 66). To minimise the risk of heat stress (in warmer months) and/or predation, animals are released at dusk, into a bush or warrens for protection.

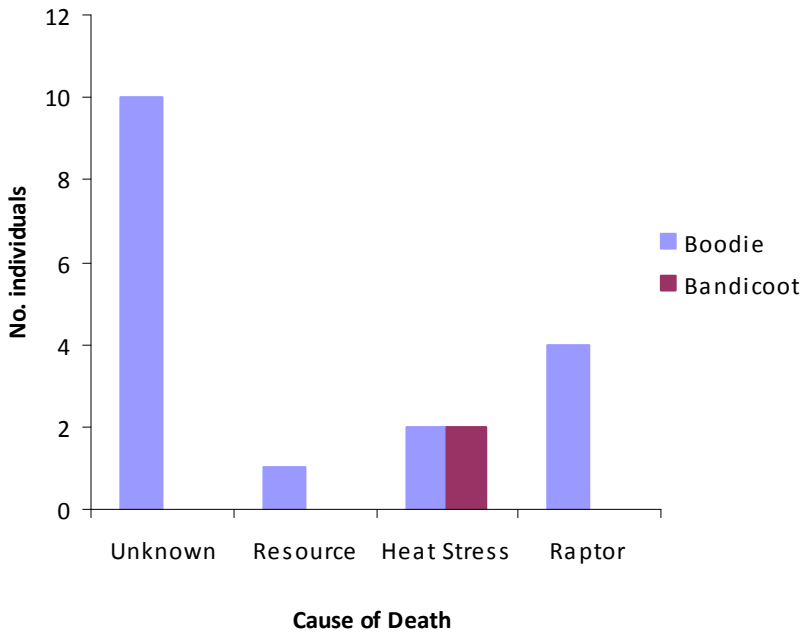

Fig. 8 The causes of mortality for boodies and golden bandicoots released within the predator proof enclosure at Lorna Glen.

2.3.5 Golden bandicoot, *Isoodon auratus*

Only two golden bandicoots are known to have died, both from heat stress (Fig. 8) during the release period when temperatures at Lorna Glen were averaging 40 - 45°C. As with boodies, the golden bandicoots are also released at dusk, into a bush or warrens for protection, to minimise the risk of heat stress and predation.

Improving Reintroduction Success

Reintroducing species into their former range is an increasingly important tool in conservation biology. However, reintroductions are labour intensive and expensive. It is well recognised that reintroductions have poor success rates and are often analysed retrospectively. In the case of Lorna Glen, we aim to improve reintroduction success through intensive real time monitoring on several levels (summarised in Table 2). In addition, maintaining low feral predators densities through continued trapping and aerial baiting is crucial to the success of wild animal releases at Lorna Glen.

Future Releases

During the next 12 months, several fauna releases are proposed at Lorna Glen:

- Captive bred bilbies (*n* = 14) from PCBC will be released at Lorna Glen in July 2010. A proportion of these individuals will be radio-collared to monitor mortality and dispersal. Individuals located within the enclosure will be monitored closely through trapping every six weeks to monitor their condition, health, survivorship and reproduction.
- Due to the poor survival of mala following their wild release in 2008, up to 30 mala will be reintroduced into the enclosure initially.
- The boodie population within the enclosure will be supplemented with animals from the RTD captive breeding colony (*n* = 100).
- F1 generation boodies and bandicoots from the fenced enclosure will be released at suitable sites outside the fence after 9-12 months.

Table 2. Actions to improve animal reintroduction success at Lorna Glen, on a population, metapopulation and ecosystem level.

Scale	Aspect	Action
Population	Population establishment	▪ Reduce predation by feral cats through an expanded aerial baiting program. ▪ Construct an fenced enclosure that will protect fauna from predation and allow acclimatisation to the Lorna Glen environment. ▪ Monitor reproduction, survival and dispersal rates ▪ Monitor acclimatisation at release site ▪ Estimate effective population size and compare to initial group size to ensure founder size sufficient
	Population persistence	▪ Ensure ongoing feral cat monitoring is undertaken and control cats where necessary. ▪ Ensure habitat requirements are met (food, shelter, predators and parasites) ▪ Ensure enough habitat is available to support reintroduced population ▪ Apply adaptive management approach to habitat conditions as population grows ▪ Apply developed criteria for future reintroduction sites
	Genetic effects	▪ Source animals from genetically diverse origins ▪ Monitor genetic diversity over time ▪ Monitor inbreeding over time using genetic data ▪ Regular supplementation of populations
Metapopulation	Populations among sites	▪ Multiple reintroductions at multiple suitable sites ▪ Develop a strategy for determining optimal number of individuals to reintroduce at a time
Ecosystem	Parasites	▪ Disease screening procedures ▪ Monitor parasite levels within populations ▪ Examine relationship between density and parasite load
	Effect of release(s)	▪ Monitor impact of reintroductions and effect on ecosystem e.g., bilbies are ecosystem engineers, potential overgrazing in the pen

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