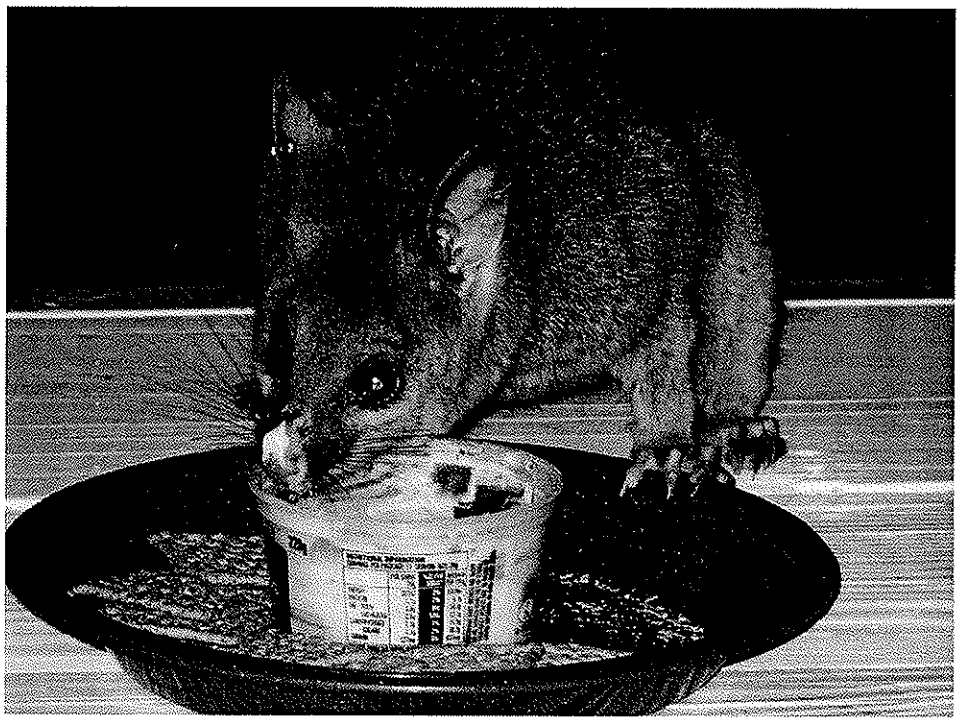
OPERATION RANGELANDS RESTORATION

FAUNA RECONSTRUCTION AT LORNA GLEN – REINTRODUCTION OF NINU AND WAYURTA



PROGRESS REPORT

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Keith Morris and Judy Dunlop

Science Division
Department of Environment and Conservation
Western Australia

INTRODUCTION

Operation Rangelands Reconstruction commenced in 2000 with the acquisition of Lorna Glen and Earaheedy pastoral leases by the Western Australian Government. This 600,000ha area lying across 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 is the reintroduction of 11 arid zone mammal species following the successful control of feral cats and foxes (Morris *et al.* 2007a).

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 Western Australia (Burbidge and McKenzie 1989). The original vision for the *Western Shield* fauna recovery program was to expand introduced predator control and translocations beyond the south-west once an operational feral cat control program had been developed, and this was also recommended by the independent review of Western Shield in 2003 (Possingham *et al.* 2004).

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 also contribute significantly to the restoration of rangeland ecosystems through activities such as digging the soil and grazing / browsing vegetation, and 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 also be considerable potential for students and other researchers to study arid zone mammal biology and ecology and related issues.

The first of the mammal reintroductions commenced in August 2007 with the release of ninu (*Macrotis lagotis*) and wayurta (*Trichosurus vulpecula*). Additional wayurta were released at Lorna Glen in May 2008. This report documents the progress with these reintroductions from August 2007 to June 2008.

INTRODUCED PREDATOR CONTROL

Feral cat baiting has been conducted annually at Lorna Glen since 2004. This has always been 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.*). This baiting regime has been successful in reducing feral cat abundance by about 2/3, to about 10 cats or less per 100 km. It has also been effective at reducing fox abundance to barely detectable levels. Dingo / wild dog activity fluctuates.

Following the cat baiting in July 2007, cat relative abundance was recorded at 6.9 $\pm$ 1.1 ($\mu \pm$ s.e.) cats per 100 km across Lorna Glen. In September, one month after the release of ninu, five cat predation events were recorded and a re-assessment of cat relative abundance was undertaken as part of the ongoing monitoring strategy. Cat abundance was recorded at 7.4 $\pm$ 1.1 cats per 100 km in October 2007. A strategic cat trapping program was implemented after the survey period as part of the active adaptive control strategy. This trapping program used a new elevated trap design that eliminated the risk to capturing bilbies in leg hold traps. Fifteen cats were trapped across the site and the cat abundance index would have been further reduced. Following this only one bilby mortality was attributed to cat predation.

RELEASE SITE DESCRIPTION

Release sites were selected during a visit to Lorna Glen in June 2007 and a report prepared on these sites (Morris *et al.* 2007b).

It was proposed that wayurta would be released at a river red gum (*Eucalyptus camaldulensis*) woodland adjacent to No. 2 Well (Wayurta 1 – 510340796 E, 7100111 N), with a secondary site (Wayurta 2) identified in a river red gum woodland near No. 10 Well (Figure 1). In May 2008, wayurta were released at three sites: No.2 Well, Possum Lake, and at Lorna Glen soak.

Three sites were identified as being suitable for ninu releases. The first site (Ninu 1 – 510350829 E, 7107854 N) was in a mulga / mallee woodland north of North Well, the second site (Ninu 2 – 510340738 E, 7092077 N) was located in a mallee woodland / Triodia grassland north of No.9 Well, and the third site (Ninu 3 – 510337372 E, 7091712 N) in red sand dunes west of No 9 Well (Figure 1).

A vegetation description and plant list for the Ninu 1 and Ninu 3 sites, provided by Daphne Edinger, is shown in Appendix 1. The Ninu 3 site (red sand dune) is more floristically diverse (44 plant species recorded) than the mulga woodland at Ninu 1 (28 plant species recorded).

FOUNDERS AND RELEASE

Ninu - 15 ninu (10 males, 5 females) from Peron Captive Breeding Centre (PCBC) were released at Ninu 3 (red sand dine site) on 8 August 2007, and another 25 (14 males, 11 females) from the Dryandra enclosure were released on 15 and 17 August 2007, also at Ninu 3. Details of the ninu released are shown in Table 1. Twelve of the 16 females released were carrying either one or two pouch young. On 25 October 2007, another six (2 males, 4 females) ninu from PCBC were released: three at Ninu 1 and three at Ninu 2. This made a total of 46 (26 male, 20 female) ninu that were released at Lorna Glen in the August – November period. Twenty seven of the ninu released (59%) were fitted with tail-mounted radio-transmitters (Sirtrack) with a four month battery life and mortality mode latched after 6 hours. A trial using neck mounted radio-collars on ninu that had stabilized their body weight 10 weeks after release failed with both animals getting their front legs caught in their collars. The collars were removed immediately.

Wayurta – Eight wayurta (5 male, 3 female) from Dryandra woodland were released at the Wayurta 1 site (Eucalypt woodland near #2 Well) on 15 August 2007. Seven of these were fitted with radio-collars (Sirtrack) with a 12 month battery life and mortality mode. Over the period 9 – 16 May 2008, another 63 (39 male, 24 female) wayurta were released at Lorna Glen, 23 of these were fitted with radio-collars. Eight of the 24 females were carrying small (up to 4cm cr) pouch young (Table 2).

MONITORING

Monitoring the survivorship, refuge use and movements of the released animals was a crucial part of this project. Several techniques were used. Between 8 August and 14 November (98 days), daily radiotracking from the ground, using handheld and a pump up aerials, was used to a) determine whether the animal was alive or dead, and b) the site and type of refuge used. Aerial tracking using a C172 aircraft fitted with wing mounted yagi aerials was used when necessary (approximately every 2 weeks) to locate ninu that had moved beyond the range of the hand held (500m) or pump up aerial (1000m). Track counts were used to detect the presence / absence of ninu, wayurta and introduced predators.

A detailed post mortem assessment was developed for this project to ensure that reasons for mortality were understood.

1. Survivorship and mortality

1.1 **Ninu:** Of the 23 ninu fitted with radio-transmitters and released in August, 16 (69%) are known to have died (Table 4). The highest cause of mortality was cat predation (40%) followed

by unknown causes (27%), starvation (20%) and raptor take (13%). A cat predation was recorded when it was obvious that the ninu had been attacked by a cat (tracks, drag marks) and the carcass showed signs of cat attack (soft organs eaten, carcass not buried, sometimes inverted). The number of unknown causes was surprising as a detailed post mortem assessment was undertaken on all mortalities. One of the animals involved appeared healthy (fat bodies etc), with no signs of internal or external injuries and had a full stomach. Snake bite, or other misadventure may have been the cause. Two other "unknowns" were animals that had moved substantial distances and had not been located for up to two weeks, so evidence for cause of death was limited. Only ninu from the PCBC died from starvation. This may reflect the greater dependence animals have on supplementary feeding in this situation, compared with the RTD captive breeding centre. The two ninu reported as raptor / scavenged most probably died of other causes. One of these was found inside a *Varanus panoptes*, which most likely scavenged an already dead ninu, rather than predating it.

All ninu mortalities happened at, or in the vicinity of the Ninu 3 (red sand dune) release site. Following the high numers of mortalities in late September / early October, the decision was made to shift surviving ninu from the Ninu 3 site to the Ninu 1 site, north of North Well. Six ninu were trapped and moved, and another three ninu are known to have moved from the Ninu 3 site to Ninu 1 site by themselves. No mortalites have been recorded at the Ninu 1 site, and there was still bilby activity in this area in May 2008 (Figure 6).

1.2 Wayurta: All of the seven wayurta fitted with radio-collars in August 2007 survived from release to December 2007. In January 2008, two males (PM04, PM05) died within a week of each other. Following a post-mortem at Murdoch University the reason for death was inconclusive, but possibly dehydration. There was no evidence of predation. A radio-collar from another animal (PM01) was removed at this time as there was some evidence of neck chafing. In May 2008, PF03 was located in a boodie warren and after a few days the transmitter went into mortality mode. A large perentie *Varanus giganteus* was seen using this warren and it is possible this wayurta was either predated or scavenged by the perentie. The body could not be retrieved from the warren.

Of the 23 wayurta fitted with radio-collars and released in May 2008, 5 (21%) are known to have died by June 30. At least 4 of these were most likely due to lack of food and moisture as the animals had lost up to 40% of their body weight and were emaciated. A fifth wayurta may have been hit by a vehicle on the main access road, the body needs to be more closely examined to confirm this. All the wayurta that died were animals that did not find and use good hollows in *E. camaldulensis* or other Eucalypt trees soon after release. There had only been 127mm of rain at Lorna Glen from November 2007 – March 2008 and the vegetation was quite dry with few flowering species. There was no sign of predation on any of the dead animals.

2. Body weights

2.1 Ninu: Over the first four months after release male ninu body weights remained stable (Figure 3), while females declined to approximately 92% of their release weight and then stabilized (Figure 4).

2.2 Wayurta: After the August 2007 release, wayurta maintained body weight (Figure 5). However after the May 2008 release animals lost up to 20% of their body weight in the first three weeks after release, but then subsequently maintained this weight or started to increase weight again. The five wayurta that died in this period had lost up to 40% of their body weight and were emaciated.

3. Refuge type

3.1 Ninu: All the ninu fitted with radio-transmitters used burrows excavated in sand or sandy loams. Two ninu were found in burrows in more rocky substrate (calcrete). Another two ninu

used burrows previously excavated by *Varanus* sp. The majority had only one entrance, however at least three of the burrows had adjacent entrances, but it was not known if these were separate burrow systems or connected to each other. Entrance dimensions averaged 15cm wide by 18cm high. Two of the burrows excavated to retrieve radio-transmitters were extensive. They were dug to a depth of 1 metre and extended horizontally for 2 metres. Each system consisted of up to 4 separate chambers connected by tunnels. There was very little plant material in the chambers.

3.2 Wayurta: Once established, all the wayurta fitted with radio-transmitters used tree hollows as day time refuge sites, predominantly in *Eucalyptus camaldulensis* along ephemeral water courses. Immediately after release some wayurta temporarily used less substantial refuge sites such as under a mallee, and in a shallow hollow near the base of *Casuarina* trees. Some of the wayurta released in May 2008 moved several kilometers away from the water courses and sheltered under shrubs and *Triodia*.

4. Movements

4.1 Ninu: Over the period of intensive monitoring (August – December 2007), ninu females each used an average of 4.4 burrows (range:1 -11 burrows), or 0.9 burrows / week. The average maximum distance between burrows was 1.3 km (range: 0.2 – 7.8 km) (Table 5). The more sedentary nature of female ninu at this time compared with males (see below) may have been due to many of them carrying pouch young or with young at heel. Up to 4 females were found sharing one burrow at a time.

Male ninu used an average of 7.6 burrows (range: 1-14) or 1.5 burrows / week. The average maximum distance between burrows was 12.2 km (range: 0.8 – 46.9 km). Three male ninu travelled > 20km over a three day period; one of these moved into the adjacent Millrose Station and was recaptured and returned to Lorna Glen (Table 5). No males were known to share with other males, but a male and female were found sharing a burrow at the Ninu 1 release site.

4.2 Wayurta: There was little difference in the numbers of tree hollows used by wayurta, or the maximum distance between individual's refuges. Females used an average of 7 tree hollows (range: 5-9), or 0.9 /week, and had a maximum distance between hollows of 4.5 km (range: 1.2 – 6.3 km). Males used an average of 8.5 tree hollows (range: 5 – 11), or 0.9 / week, and moved up to 5.1 km between hollows (range: 1.2 – 7.9 km) (Table 6).

ASSESSMENT AGAINST TRANSLOCATION PROPOSAL SUCCESS CRITERIA

The approved Translocation Proposals provided criteria by which the translocations to Lorna Glen could be assessed. These are shown below, along with an assessment of progress (*in italics*)

The ninu translocation will be considered successful if the following are achieved:

- Better than 60% survival by 30 November 2007 – *there was only 31% survival of ninu fitted withy radio-transmitters at the Ninu 3 release site, however there has been no known mortality at the Ninu 1 release site..*
- Body weight of survivors has been maintained or increased by 30 November 2007 – *body weight of male ninu declined initially then increased to approximately 90% of release weight. Female ninu body weights declined over the first 9 weeks.*
- The appearance of pouch young known to have been conceived at Lorna Glen by March 2008 – *at least three females conceived and gave birth at Lorna Glen by December 2007.*
- The appearance of new, unmarked ninu in the population – *to be assessed later in 2008.*
- The successful expansion of ninu into large areas of suitable habitat after 18 months – *to be assessed in 2009.*
- An estimated population > 200 by August 2010 – *to be assessed in 2010*

The wayurta translocation will be considered successful if the following are achieved:

- Better than 60% survival by 30 November 2007 – *there was 100% survival of radio-collared wayurta to January 2008. This had reduced to 65% survival by May 2008, after the deaths of 3 radio-collared animals. Of the wayurta released in May 2008, 79% are known to have survived until the end of June 2008.*
- Body weight of survivors has been maintained or increased by 30 November 2007 – *after an initial decline in body weight, all wayurta released in August 2007 increased weight to above release weights. Wayurta released in May 2008 declined in body weight by up to 20%, but then either maintained or increased body weight.*
- The appearance of pouch young known to have been conceived at Lorna Glen by May 2008 – *none of the radiocollared females released in August 2007 were found to have pouch young in May 2008.*
- The appearance of new, unmarked wayurta in the population by August 2008 – *to be assessed in August 2008.*
- The successful expansion of wayurta into large areas of suitable habitat after 18 months – *to be assessed in 2009.*
- An estimated population > 200 by August 2010 – *to be assessed in 2010.*

FUTURE TRANSLOCATION / RECOMMENDATIONS

Despite an initial high level of mortality among founder ninu at the Ninu 3 release site, the survivors that were recaptured and re-released at the Ninu 1 site have survived (at least to January 2008) and breeding has occurred. Survivorship of wayurta has been good and, following an initial decline, body weights of founders has been maintained or increased. The following recommendations are made:

1. That monitoring of wayurta continue through 2008 and a decision made about further restocking in February 2009.
2. That at least another 40 ninu from a wild population on Thistle Island (SA) and the Dryandra captive breeding enclosures be translocated to Lorna Glen in August 2008.
3. That a Translocation Proposal and Animal Ethics approval be prepared for translocating mala (*Lagorchestes hirsutus*) to Lorna Glen from the Peron Captive Breeding Centre and Dryandra in September 2008. These were completed and AEC approval was obtained on 20 June.

ACKNOWLEDGEMENTS

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Animal #	Source site	Animal ID	Sex	Body weight (g)	Pouch young at release	Release site	Date and time of release	Radio-transmitter fitted?	Comments
BF01	Peron	00-066D-F3AO	F	1580	1py	Ninu 3	8/08/07, 1800	yes	
BF02	Peron	00-0699-5F09	F	1010	2py	Ninu 3	8/08/07, 1800	yes	
BM03	Peron	00-066E-05EE	M	2320		Ninu 3	8/08/07, 1800	yes	Shifted to Ninu 1 site Oct 2007
BM04	Peron	00-0699-5D4F	M	1320		Ninu 3	8/08/07, 1800	yes	
BF05	Peron	00-0699-5218	F	1090	no py	Ninu 3	8/08/07, 1800	yes	
BM06	Peron	00-066D-C3B8	M	1855		Ninu 3	8/08/07, 1800	yes	
BF07	Peron	00-0698-5A0B	F	1040	2py	Ninu 3	8/08/07, 1800	yes	Shifted to Ninu 1 site Oct 2007
BF08	Peron	00-0699-7A4C	F	1030	2py	Ninu 3	8/08/07, 1800	yes	
BM09	Peron	00-0699-41DF	M	1020		Ninu 3	8/08/07, 1800	yes	
BM10	Peron	00-0699-7A55	M	1370		Ninu 3	8/08/07, 1800	yes	
BM11	Peron	00-0699-6F3B	M	1270		Ninu 3	8/08/07, 1800	no	
BM12	Peron	00-0698-36F7	M	1290		Ninu 3	8/08/07, 1800	no	
BM13	Peron	00-0698-854A	M	870		Ninu 3	8/08/07, 1800	yes	Shifted to Ninu 1 site Oct 2007
BM14	Peron	00-0699-444B	M	1050		Ninu 3	8/08/07, 1800	no	
BM15	Peron	00-0699-70C1	M	1000		Ninu 3	8/08/07, 1800	no	
BM16	Dryandra	00-0670-0A0E	M	942		Ninu 3	15/8/07, 1900	yes	
BM17	Dryandra	00-0638-1DDD	M	1618		Ninu 3	15/8/07, 1900	yes	
BF18	Dryandra	00-0671-25C2	F	971	1py	Ninu 3	15/8/07, 1900	yes	
BF19	Dryandra	00-0637-E292	F	987		Ninu 3	15/8/07, 1900	yes	Shifted to Ninu 1 site Oct 2007
BM20	Dryandra	00-0666-7AF5	M	985		Ninu 3	15/8/07, 1900	yes	Shifted to Ninu 1 site Oct 2007
BM21	Dryandra	00-0671-3B7F	M	1079		Ninu 3	15/8/07, 1900	yes	
BM22	Dryandra	00-066E-A386	M	1577		Ninu 3	15/8/07, 1900	yes	Shifted to Ninu 1 site Oct 2007
BF23	Dryandra	00-0666-969F	F	1037	2py	Ninu 3	15/8/07, 1900	yes	
BF24	Dryandra	00-0603-1657	F	909	2py	Ninu 3	17/8/07, 1900	yes	
BF25	Dryandra	00-066D-CCEC	F	1056	2py	Ninu 3	15/8/07, 1900	yes	
BF26	Dryandra	00-0673-696F	F	1144	2py	Ninu 3	15/8/07, 1900	yes	
BF27	Dryandra	00-066C-82AE	F	1108		Ninu 3	15/8/07, 1900	yes	
BM28	Dryandra	00-066E-0O75	M	1236		Ninu 3	17/8/07, 1900	yes	
BM29	Dryandra	00-066E-1BBD	M	745		Ninu 3	17/8/07, 1900	no	
BM30	Dryandra	00-066E-149A	M	871		Ninu 3	17/8/07, 1900	no	
BM31	Dryandra	00-066E-2F2D	M	772		Ninu 3	17/8/07, 1900	no	
BF32	Dryandra	00-0671-	F	664		Ninu 3	17/8/07,	no	

		1D94					1900		
BM33	Dryandra	00-0652-95B2	M	1436		Ninu 3	17/08/07, 1800	no	
BM34	Dryandra	00-0671-2C26	M	1218		Ninu 3	17/08/07, 1800	no	
BM35	Dryandra	00-066E-04C1	M	705		Ninu 3	17/08/07, 1800	no	
BF36	Dryandra	00-0671-34FB	F	761	2py	Ninu 3	17/08/07, 1800	no	
BF37	Dryandra	00-066E-2118	F	875	1py	Ninu 3	17/08/07, 1800	no	
BM38	Dryandra	00-066D-C53C	M	1129		Ninu 3	17/08/07, 1800	no	
BF39	Dryandra	00-066C-3DC4	F	977	1py	Ninu 3	17/08/07, 1800	no	
BM40	Dryandra	00-066E-4060	M	1220		Ninu 3	17/08/07, 1800	no	
BM41	Peron	00-0698-7C6D	M	1035		Ninu 2	25/10/07 1800	yes	
BF42	Peron	00-0698-73D7	F	1425	2py	Ninu 2	25/10/07 1800	yes	
BF43	Peron	00-0697-861A	F	895	no py	Ninu 1	25/10/07 1900	yes	
BF44	Peron	00-0699-517A	F	610	no py	Ninu 1	25/10/07 1900	yes	
BF45	Peron	00-0699-59AF	F	580	no py	Ninu 2	25/10/07 1800	no	
BM46	Peron	00-0698-5AA7	M	590		Ninu 1	25/10/07 1900	no	

Table 1. Details of ninu released at Lorna Glen: August – October 2007

Animal #	Source site	Animal ID	Sex	Body weight (g)	Pouch young at release	Release site	Date and time of release	Radio-transmitter fitted ?	Comments
PM01	Dryandra	1341/1342	M	1725		Wayurta 1	15/08/07, 2000	yes	
PM02	Dryandra	1339/1340	M	1725		Wayurta 1	15/08/07, 2000	yes	
PF03	Dryandra	1343/1344	F	1000	1py furred	Wayurta 1	15/08/07, 2000	yes	Died May 2008
PM04	Dryandra	1333/1334	M	2050		Wayurta 1	15/08/07, 2000	yes	Died Jan 2008
PM05	Dryandra	1335/1336	M	1800		Wayurta 1	15/08/07, 2000	yes	Died Jan 2008
PF06	Dryandra	3735/1337??	F	1675	1py naked	Wayurta 1	15/08/07, 2000	yes	
PF07	Dryandra	3773/3774	F	1975	0	Wayurta 1	15/08/07, 2000	yes	
PM08	Dryandra	??1337/1338	M	1325		Wayurta 1	15/08/07, 2000	no	
PM09	Dryandra/Lorna Glen		M			Possum Lake		no	Py of PF06

Table 2. Details of wayurta released at Lorna Glen in August 2007.

Animal #	Source site	Animal ID	Sex	Body weight (g)	Pouch young at release	Release site	Date and time of release	Radio-transmitter fitted?	Comments
PM10	Boyagin	N5286/N5287	M	1790		Lorna Glen soak	9/05/08, 2000	yes	
PM11	Boyagin	N2635/N2634	M	1620		Lorna Glen soak	9/05/08, 2000	yes	
PF12	Boyagin	N4285/N4284	F	1480	1py, 4cm	homestead	9/05/08, 2000	yes	
PF13	Boyagin	W6976/W3608	F	1590	1py, 3cm	Lorna Glen soak	9/05/08, 2000	yes	
PM14	Boyagin	N5308/N5307	M	1740		Lorna Glen soak	9/05/08, 2000	yes	
PM15	Boyagin	N5277/N5276	M	1780		homestead	9/05/08, 2000	yes	Re-released south of #1 Well, died
PF16	Boyagin	N5390/N5391	F	1540	1py, 2cm	Lorna Glen soak	9/05/08, 2000	yes	
PF17	Boyagin	N5349/N5348	F	1560	1py, 2cm	Lorna Glen soak	9/05/08, 2000	yes	died
PM18	Mt Caroline / Curtin Uni	527/528	M	1910		homestead	9/05/08, 2000	yes	
PM19	Karakamia	K1426/K1427	M			#2 Well	14/5/08, 2000	yes	
PF20	Karakamia	K1428/K1429	F		0 py	#2 Well	14/5/08, 2000	yes	
PF21	Karakamia	P625/K1415	F		0 py	#2 Well	14/5/08, 2000	yes	
PM22	Karakamia	K1434/K1435	F		0 py	Possum Lake	14/5/08, 2000	yes	Re-released south of #1 Well
PF23	Karakamia	K1366/K1367	F		0 py	homestead	14/5/08, 2000	yes	
PM24	Karakamia	K1431/K1430	M			Possum Lake	14/5/08, 2000	yes	
PF25	Karakamia	K1422/K1421	F		0 py	#2 Well	14/5/08, 2000	yes	
PM26	Karakamia	K1466/K1467	M	1450		Lorna Glen soak	16/05/08, 2000	yes	
PM27	Karakamia	K1445/K1446	M	1400		Lorna Glen soak	16/05/08, 2000	yes	died
PM28	Karakamia	K1470/K1471	M	1900		# 2 Well	16/05/08, 2000	yes	died
PF29	Karakamia	K1443/K1444	F	1925	1 py, 2.5cm	# 2 Well	16/05/08, 2000	yes	
PF30	Karakamia	K1497/K1496	F	1550	0 py	Possum Lake	16/05/08, 2000	yes	Re-released south of #1 Well
PM31	Karakamia	K1367/K1368	M	1530		# 2 Well	16/05/08, 2000	yes	
PM32	Karakamia	K1472/K1473	M	1570		Lorna Glen soak	16/05/08, 2000	yes	died
PM33	Mt Caroline / Curtin Uni	1652/1651	M	2140		Possum Lake	9/05/08, 2000	no	
PM34	Mt Caroline / Curtin Uni	509/503	M	1940		# 2 Well	9/05/08, 2000	no	
PM35	Mt Caroline / Curtin Uni	559/574	M	1850		# 2 Well	9/05/08, 2000	no	
PM36	Mt Caroline / Curtin Uni	1362/missing	M	2030		# 2 Well	9/05/08, 2000	no	
PM37	Mt Caroline / Curtin Uni	1643/1642	M	1650		# 2 Well	9/05/08, 2000	no	

PF38	Karakamia	K1548/K1536	F	900		Homestead	14/05/08, 2000	no	
PF39	Karakamia	K1542/K1543	F	1250		Possum Lake	14/05/08, 2000	no	
PF40	Karakamia	K1540/K1541	F	1500		# 2 Well	14/05/08, 2000	no	
PF41	Karakamia	K1439/K1438	F	2070		# 2 Well	14/05/08, 2000	no	
PM42	Karakamia	K1477/K1476	M	1955		# 2 Well	14/05/08, 2000	no	
PM43	Karakamia	K1437/K1436	M	1020		# 2 Well	14/05/08, 2000	no	
PM44	Karakamia	K1420/K1419	M	1175			14/05/08, 2000	no	
PM45	Karakamia	K1417/K1418	F	1550	1 py, 2cm		14/05/08, 2000	no	
PM46	Karakamia	K1479/K1416	F	1800			14/05/08, 2000	no	
PM47	Karakamia	K1453/K1142	M	1800			16/05/08, 2000	no	
PM48	Karakamia	K1411/K1410	M	1825			16/05/08, 2000	no	
PM49	Karakamia	K1469/K1468	M	1540			16/05/08, 2000	no	
PM50	Karakamia	K1499/K1498	M	1925			16/05/08, 2000	no	
PM51	Karakamia	K1545	M	1550			16/05/08, 2000	no	
PM52	Karakamia	K1237/K1238	M	1250			16/05/08, 2000	no	
PM53	Karakamia	K1239/K1438	M	1750			16/05/08, 2000	no	
PM54	Karakamia	K1439/K1440	M	1100			16/05/08, 2000	no	
PM55	Karakamia	K1442/K1441	M	1800			16/05/08, 2000	no	
PM56	Karakamia	K1478	M	1700			16/05/08, 2000	no	
PM57	Karakamia	K1456/K1455	M	1450			16/05/08, 2000	no	
PM58	Karakamia	K1458/K1457	M	1750			16/05/08, 2000	no	
PF59	Karakamia	609/K1399	F	1680	1py		16/05/08, 2000	no	
PM60	Boyagin	N5281/N5280	M	1600		Lorna Glen soak	9/05/08, 2000	no	
PF61	Boyagin	N5279/N5278	F	1325	1py	Lorna Glen soak	9/05/08, 2000	no	
PM62	Boyagin	N4320/N4323	M			Lorna Glen soak	9/05/08, 2000	no	
PM63	Boyagin	N5372/5373	M			Lorna Glen soak	9/05/08, 2000	no	
PM64	Boyagin	N3697/N3698	M			Lorna Glen soak	9/05/08, 2000	no	
PF65	Boyagin	N5395/N5396	F			Lorna Glen soak	9/05/08, 2000	no	
PF66	Boyagin	N5379/N5370	F			Lorna Glen soak	9/05/08, 2000	no	
PM67	Boyagin	KA262/432	M			Lorna Glen soak	9/05/08, 2000	no	
PF68	Boyagin	5369	F			Lorna Glen soak	9/05/08, 2000	no	
PM69	Boyagin	N5366/N5367	M			Lorna Glen soak	9/05/08, 2000	no	
PM70	Boyagin	N5365/N5364	M			Lorna Glen soak	9/05/08, 2000	no	
PFM71	Boyagin	N3608	F			Lorna Glen soak	9/05/08, 2000	no	
PF72	Boyagin	N4299/N2613	F			Lorna Glen soak	9/05/08, 2000	no	

Table 3. Details of Wayurta released at Lorna Glen in May 2008

Founder Source	Peron Captive Breeding Centre		Dryandra enclosure		
	Male	Female	Male	Female	TOTAL
Cat predation	1	1	2	2	6 (38%)
Other predation / scavenged	0	1	1	3	5 (31%)
Starvation	2	1	0	0	3 (19%)
Unknown	0	1	0	1	2 (12%)
TOTAL	3	4	3	6	16

Table 4. Mortality of ninu at Lorna Glen: August – November 2007.

Species	Animal ID	Sex	# Days Monitored	# Refuges used	# Refuges per week	Max Dist km
Ninu	1	F	47	6	0.9	1.3
Ninu	2	F	52	4	0.5	7.8
Ninu	5	F	51	6	0.8	0.4
Ninu	7	F	83	8	0.7	1.1
Ninu	8	F	84	8	0.7	0.9
Ninu	18	F	41	6	1.0	0.7
Ninu	19	F	78	11	1.0	0.6
Ninu	23	F	27	1	0.3	
Ninu	24	F	30	1	0.2	
Ninu	25	F	33	2	0.4	0.2
Ninu	26	F	84	4	0.3	1.0
Ninu	27	F	10	3	2.1	0.4
Ninu	42	F	10	2	1.4	0.5
Ninu	43	F	3	1	2.3	
Ninu	44	F	10	3	2.1	0.3
			average	*4.4*	*1.0*	*1.3*

a) female ninu

Species	Animal ID	Sex	# Days Monitored	# Refuges used	# Refuges per week	Max Dist km
Bilby	3	M	88	14	1.1	6.0
Bilby	4	M	40	8	1.4	2.1
Bilby	6	M	86	8	0.7	7.1
Bilby	9	M	23	6	1.8	0.8
Bilby	13	M	49	8	1.1	17.1
Bilby	16	M	33	3	0.6	1.3
Bilby	17	M	22	1	0.3	
Bilby	20	M	81	12	1.0	46.9
Bilby	21	M	89	13	1.0	26.6
Bilby	22	M	81	13	1.1	23.3
Bilby	28	M	34	3	0.6	2.1
Bilby	41	M	2	2	7.0	1.2
			average	*7.6*	*1.5*	*12.2*

b) male ninu

Table 5. Numbers of refuges used (burrows) by a) female and b)male ninu at Lorna Glen, and the maximum distances between individuals refuges.

Species	Animal ID	Sex	# Days Monitored	# Refuges used	# Refuges per week	Max Dist km
Wayurta	3	F	59	5	0.6	6.1
Wayurta	6	F	60	9	1.1	6.3
Wayurta	7	F	52	7	0.9	1.2
			average	*7.0*	*0.9*	*4.5*

Species	Animal ID	Sex	# Days Monitored	# Refuges used	# Refuges per week	Max Dist km
Wayurta	1	M	59	11	1.3	7.9
Wayurta	2	M	68	5	0.5	1.2
Wayurta	4	M	60	9	1.1	8.2
Wayurta	5	M	68	9	0.9	3.2
			average	*8.5*	*0.9*	*5.1*

Table 6. Numbers of refuges used (tree hollows) by female and male wayurta at Lorna Glen, and the maximum distances between individuals refuges.

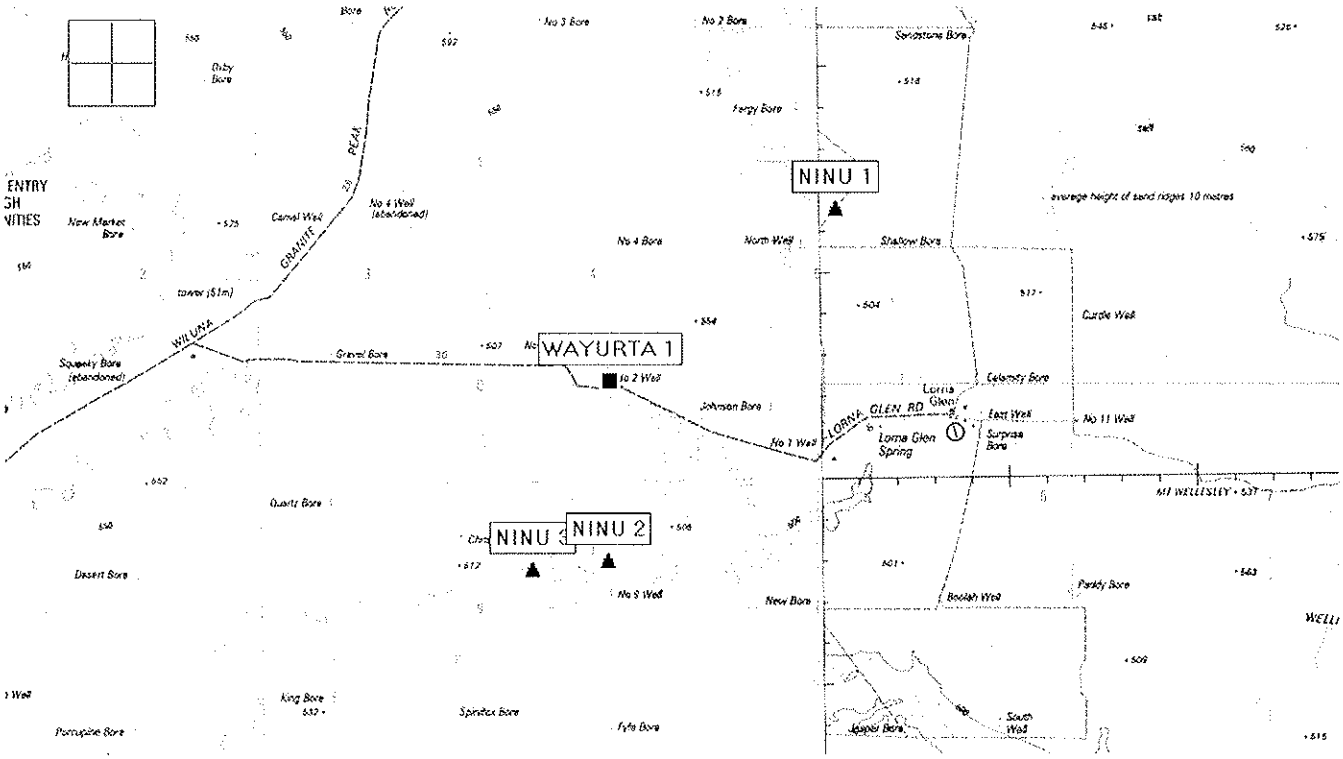

Figure 1. August 2007 release sites for ninu and wayurta at Lorna Glen

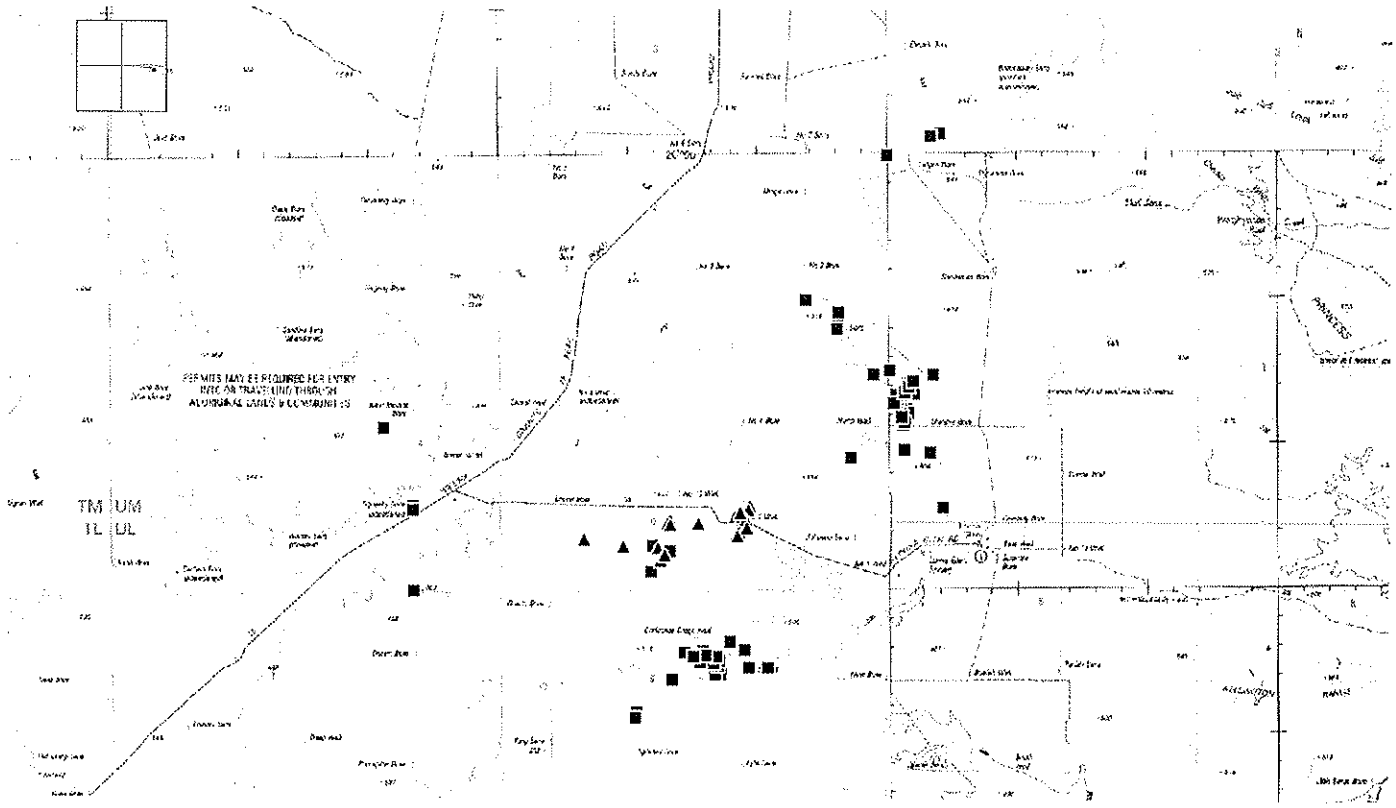

Figure 2. Refuge site locations for ninu ■ and wayurta▲ in the period August – November 2007.

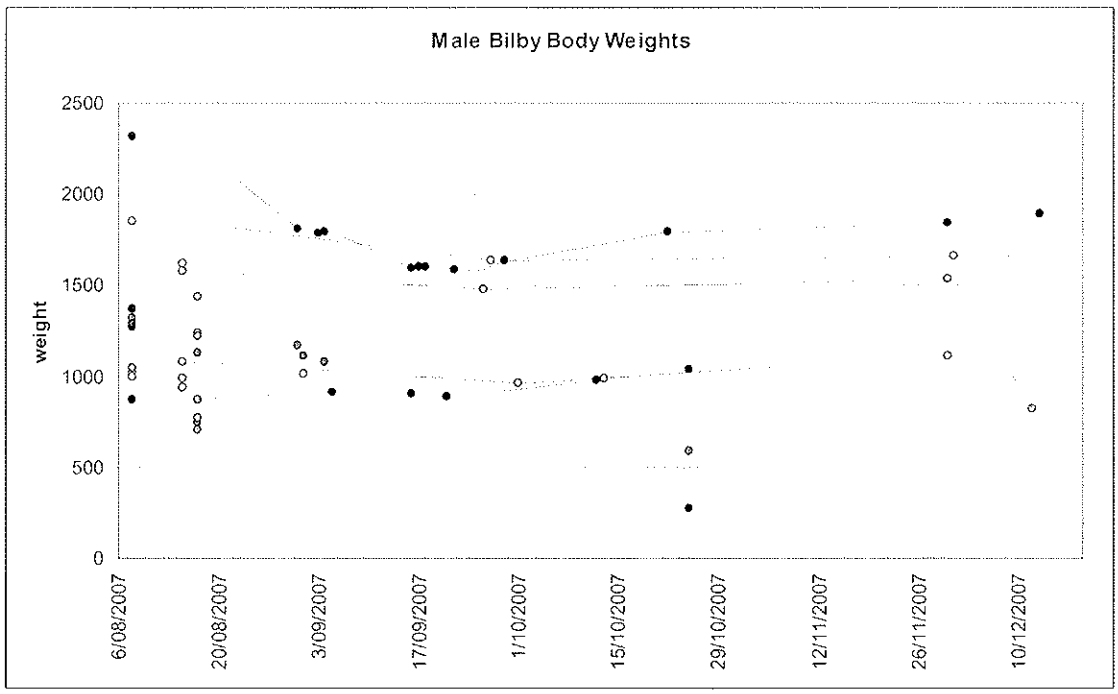

Figure 3. Body weights of male ninu after release at Lorna Glen.

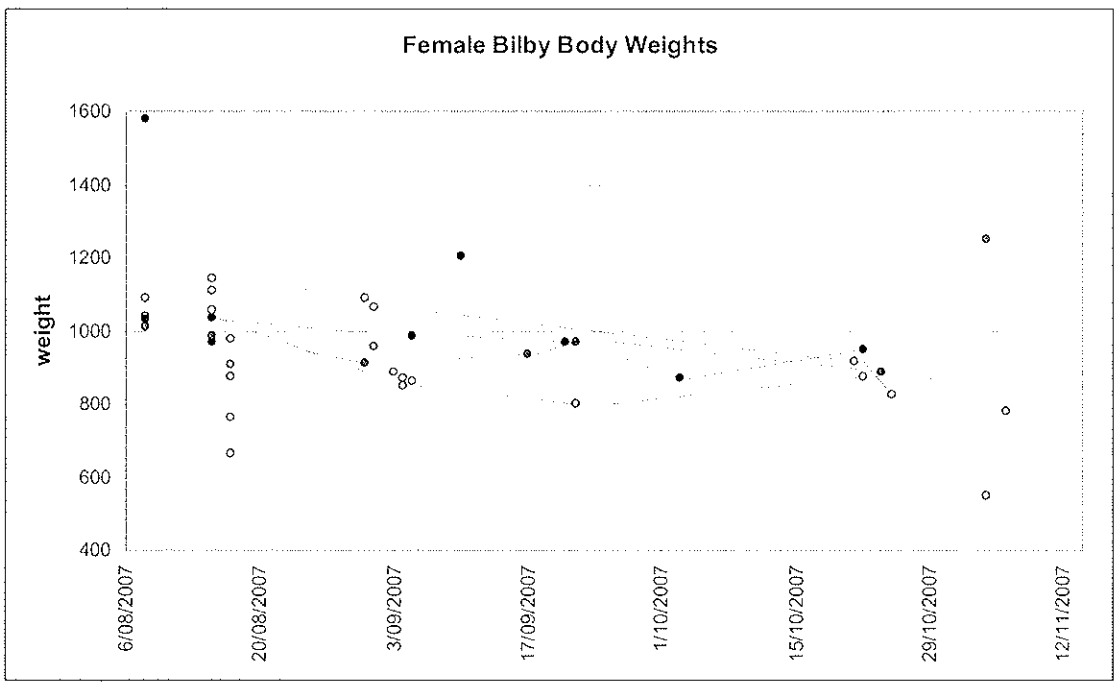

Figure 4. Body weights of female ninu after release at Lorna Glen.

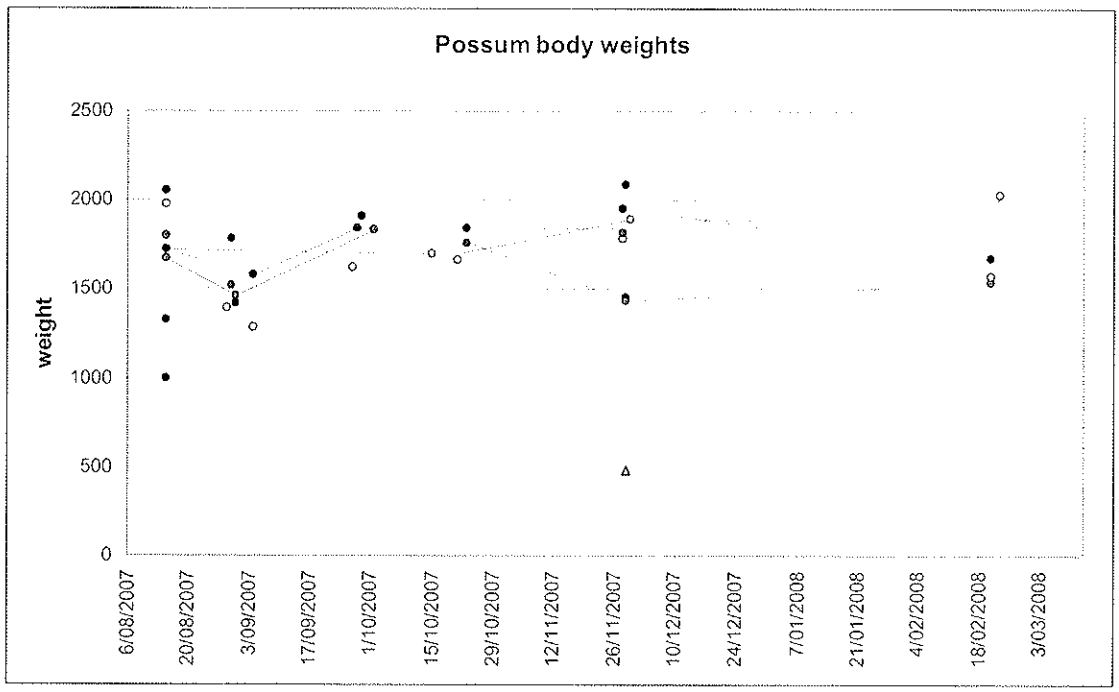

Figure 5. Body weights of wayurta released at Lorna Glen in August 2007.

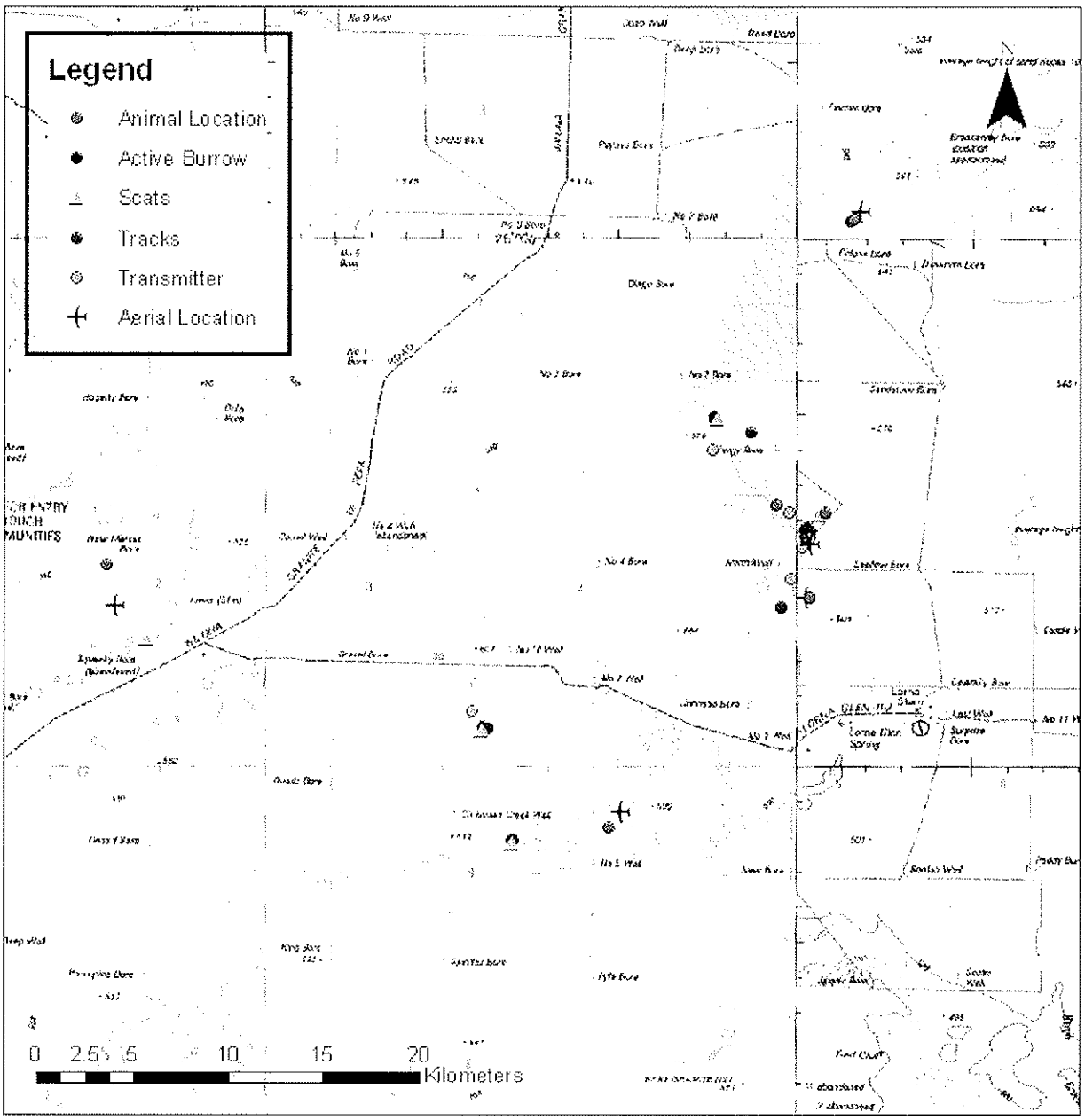

Figure 6. Persistence of ninu at Lorna Glen: December 2007 – March 2008

Appendix 1 – Vegetation and flora at the Ninu 1 and Ninu 3 release sites.

Ninu 1 - 3 km north east of North Well (510350829 E, 7107854 N)

Mulga and mallee woodland (*Acacia anuera* var *alata, Eucalypyus eremicola*) over shrubs (*Eremophila*) and grassland (*Triodia*), on brown clay loam. Bare ground 25%.

Abutilon cryptopetalum
Acacia aneura var *alata* ms
Acacia aneura BRM 9318 aff *minura*
Acacia aneura var *argentea*
Acacia burkittii
Acacia minyura
Acacia pruinocarpa
Acacia ramulosa var *linophylla*
Acacia tetragonophylla
Aristida contorta
Enteropogon caerulescens
Eragrostis eriopoda
Eremophila forrestii
Eremophila gilesii
Eremophila margarethae
Eucalyptus kingsmillii
Eucalyptus eremicola ssp. *eeneri*
Monachather paradoxus
Podaxis pistillaris
Ptilotus polystachyus
Ptilotus obovatus
Psydrax suaveolens
Rhagodia eremaea
Senna artemisioides filifolia
Sida excedentifolia
Solanum lasiophyllum
Triodia melvillei
Templetonia egena

Ninu 3 – 2 km west of Number 9 Well (510337372 E, 7091712 N)

Site Description
Low red sand dunes to 10 m and swales in Bullimore land system. Low *Acacia* shrubs to 3 m, scattered *Corymbia* and *Eucalyptus* (mallee), *Grevillea, Hakea*, *Aluta*, and *Dodonaea* shrubs, with *Triodia* and *Arista* grass understorey. 30% bare ground. *Aluta* is the dominant shrub.

Acacia? clelandii
Acacia jamesiana aessiana
Acacia ligulata
Acacia minyura
Acacia. plenocarpa
Acacia prainii
Acacia rammulosa var *linophylla*
Acacia. tetragonophylla
Aluta maisonneuvei ssp. *auriculata*

Alyogyne pinoniana
Anthotroche pannosa shrub
Anthobolus leptomerioides
Aristida sp
Bonamia rosea
Casuarina pauper
Crypostemon ramulosa
Chrysogonum puteale
Dicrastylis georgei
Dodonea? viscosa
Eragrostis eriopoda grass
Eremophila platythamnos
Eucalyptus lenziana
Eucalyptus kingsmillii
Grevillea juncifolia
Grevillea nematophylla
Grevillea stenobotrya
Hakea lorea
Hibiscus sp.
Leptosema chambersii
Keraudrenia velutina ssp *attepticum*
Paraneurachne muelleri
Petalostylis cassioides
Pittosporum augustifolium
Prostanthera
Ptilotus obovatus
Santalum acuminatum
Santalum lanceolatum
Senna artemisioides ssp *filifolia*
Senna glutinosa ssp*?*
Solanum? centrale
Solanum lasiophyllum
Solanum sp.
Triodia melvillei
Triodia basedowii

Appendix 2 – List of participants (team leader in bold)

TEAM #	DATES	TEAM MEMBERS	AFFILIATION
1	6 - 24 August	**Keith Morris**	Science, Woodvale
		Brent Johnson	Science, Woodvale
		Judy Dunlop	Science, Woodvale
		Peter Orell	Nat Cons, Kensington
		Steve Toole	Reg Serv, Kalgoorlie
		Lauren	Reg Serv, Kalgoorlie
		Ninon Meyer	Volunteer / Science
		Ash Marincsin	Volunteer / Science
2	21 Aug - 7 Sept	**Neil Thomas**	Science, Woodvale
		Jennifer Jackson	Science, Woodvale
		Peter Orell	Nat Cons, Kensington
		Chris Vellios	Science, Manjimup
3	4 - 21 Sept	**Graeme Liddelow**	Science, Manjimup
		Brad Barton	Reg Serv, Manjimup
		Karlene Bain	Reg Serv, Walpole
		Renee Berry	Reg Serv, Kalgoorlie
4	18 Sept - 4 Oct	**Judy Dunlop**	Science, Woodvale
		Gary Herle	Reg Serv, Kalgoorlie
		Ryan Butler	Reg Serv, Kalgoorlie
		Keith Morris	Science, Woodvale
		Ninon Meyer	Volunteer / Science
		Neil Burrows	Science, Kensington
5	2 - 19 Oct	**Jennifer Jackson**	Science, Woodvale
		Aaron Woosnam	Reg Serv, Kalgoorlie
		Marnie Swinburn	Reg Serv, Manjimup
6	16 Oct - 1 Nov	**Keith Morris**	Science, Woodvale
		Ninon Meyer	Science, Woodvale
		Marika Maxwell	Science, Manjimup
		Pia Courtis	Reg Serv, Kalgoorlie
7	30 Oct - 16 Nov	**Colin Ward**	Science, Manjimup
		Julie Patten	Reg Serv, Kalgoorlie
		Cathy Lambert	Perth Zoo
		Belinda Turner	Perth Zoo
		Judy Dunlop	Science, Woodvale
8	26 Nov - 2 Dec	**Keith Morris**	Science, Woodvale
		Glen Gaikhorst	Perth Zoo
		Michael Cranley	Perth Zoo
		Peter Orell	Nat Cons, Kensington
	Aircraft	Peter McGinty, Jamie Flett	