Biodiversity and Conservation Science

Translocation of golden bandicoots, *Isoodon auratus barrowensis*, from a fenced enclosure to unfenced managed land on Matuwa (formally Lorna Glen) in September 2015: Final report

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Cover image
Left- Collared Golden Bandicoot before translocation, Right- Jennifer Eliot (volunteer) radio tracking translocated bandicoots. Photos Mark Blythman

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Many people have contributed to the golden bandicoot translocation project from translocating the founding animals to Matuwa from Barrow Island, to monitoring the translocated population. In addition to the Department of Biodiversity, Conservation and Attractions staff there have been countless volunteers helping directly on the ground and behind the scenes. We thank everyone involved as without their efforts the work would not have been able to go ahead.

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Summary

In September 2015, 92 bandicoots were translocated from a predator-free enclosure to two unfenced release sites on the Matuwa Indigenous Protected Area in central Western Australia (Translocation Proposal 273). Intensive predator control preceded the release and continued for three months post release. The project met the criteria for short term success. Whether the project met the criteria for medium/long term success is uncertain as a founder animal was recaptured 18 months after translocation and there was evidence of breeding individuals but there was no evidence that the translocation increased the presence, persistence, or density of the golden bandicoot population outside the predator-free enclosure. Opportunistic observations from 2011 to 2014 suggest that golden bandicoots were naturally emigrating out of the predator-free enclosure at a slow rate. Data from 2-hectare track plot surveys in 2019, four years after the translocation, suggest that golden bandicoots continue to persist outside of the predator-free enclosure at very low densities.

Introduction

The Rangelands Restoration project aims to reintroduce 12 species of mammals back to the Matuwa Indigenous Protected Area, formerly known as Lorna Glen (Algar *et al.* 2013; Bode *et al.* 2012).

The Matuwa Indigenous Protected Area, an ex-pastoral lease, is a 244,000 ha property located in the Goldfields Region of Western Australia (26°13'S 121°33'E), which was purchased by the Western Australian State Government in 2000. In 2014 exclusive possession native title was awarded to the Tarlka Matuwa Piarku Aboriginal Corporation (TMPAC) and Matuwa now forms part of the Matuwa - Kurrara Kurrara Indigenous Protected Area and is jointly managed by the Department of Biodiversity, Conservation and Attractions (DBCA) and the Wiluna Martu Traditional Owners.

Bilbies (*Macrotis lagotis*) and brushtail possums (*Trichosurus vulpecula*) were successfully reintroduced to Matuwa between 2007 and 2010 and continue to persist across the property (Sims *et al.* 2017; Lohr 2019). In 2008, attempts to reintroduce mala (*Lagorchestes hirsutus*) and boodies (*Bettongia lesueur*) to Matuwa failed due to predation from native and introduced predators (Lohr 2019; Sims and Morris 2015). In response, a 1100 ha introduced predator-free enclosure was constructed (Bode *et al.* 2012).

One hundred and sixty-two golden bandicoots (*Isoodon auratus barrowensis*) from Barrow Island were released into the 1100 ha introduced predator-free enclosure at Matuwa in February 2010 (Dunlop and Morris 2012). The predator-free enclosure was to be used to acclimatise golden bandicoots to the local environment in a secure area where they had access to supplementary feed and were free from feral predators. The golden bandicoot translocation was proposed as a reintroduction/restocking project as opposed to an introduction, as sub-fossil evidence of this species exists at this location (Baynes 2006).

Between 2011 and 2014 there were opportunistic sightings and evidence of golden bandicoots outside the predator-free enclosure (Figure 1). Anecdotal evidence indicated that small bandicoots were able to make their way through the fence.

Between 19-20 May 2012, 49 bandicoots (19 radio-collared) were translocated out of the predator-free enclosure, to an area of spinifex sand plain habitat on the northern edge of Possum Lake (26°13'S 121°21'E) (Dunlop and Morris 2012). This was undertaken without any additional predator control being employed prior to the release beyond the annual aerial feral cat bait in July 2011. Regular track count monitoring indicated that the feral cat Track Activity Index (TAI) (Algar *et al.* 2013) was 4.7 in January 2012, and had been kept consistently at or below the target criteria (TAI <10.0) set for releases to occur since winter 2004 (almost 8 years) (Burrows & Ward, 2012). Despite this, subsequent predator monitoring in June 2012 after the golden bandicoot release had occurred, showed that there had been a tripling of the feral cat TAI to 14.7 in the intervening five months.

As a result, the translocation was deemed a failure, with the loss (unknown fate) or death of all 19 collared animals within 53 days. Monitoring within the release area after this time, failed to reveal any fresh sign of released animals. Necropsies of whole or partial carcasses suggested that feral cats *Felis catus* (9/19 = 47%), dogs *Canis familiaris* (1/19 = 5%) and raptors (1/19 = 5%) preyed upon collared bandicoots. The cause of death could not be determined for two carcasses found within 10 days of the translocation which did not show signs of predation (10%). Five bandicoots slipped their tracking collars (26%), and the signal for one bandicoot could not be relocated (5%). One uncollared bandicoot carcass was found and revealed to be predated by a feral cat. Most of the translocated bandicoots were lost to predation, despite a management response which entailed trapping and baiting for feral predators in the immediate release area and 5 km of surrounding tracks 8 days post release, and within 2 days of the first predation event.

Radio tracked bandicoots utilised refuges up to 1.2 km from the release sites, and some bandicoots were located up to 9 km away. Given this level of mobility, monitoring the collared bandicoots to determine survival and cause of death was significantly hampered by the poor performance and limited range (<250 m) of the transmitters used (Sims and Morris 2015).

In 2014 there was a new proposal to translocate golden bandicoots from the fenced area at Matuwa to an unfenced area south of the enclosure. However, the planned translocation was postponed as, even after the annual aerial feral cat baiting program, there were estimated to be more than two feral cats within the release area and a total TAI across Matuwa of 15.8 (Burrows *et al.* 2014). As the decision to defer the translocation was made at a very late stage, and extensive personnel and volunteer resources as well as radio collars were already committed to the project, a decision was made to gather more information about the potential home range movements and habitat use of bandicoots within the enclosure to inform future translocations.

Bandicoots were collared and radio tracked within the predator-free enclosure to determine home range size and refuge descriptions. This project tracked 20 bandicoots over 40 days. A total of 289 diurnal refuges were located suggesting that golden bandicoots primarily refuge in spinifex (*Triodia basedowii*) with 84% of diurnal refuges in spinifex and 13% in other vegetation listed in order of occurrence: hollow logs, under grass, in burrows and under shrubs. It was also identified that the majority of bandicoots that were utilising more open mulga habitat for foraging, were also still generally using diurnal refuges within spinifex, despite travelling up to 1 km each way to do so.

The pre-bait/post-bait feral cat TAI data suggested that aerial baiting in 2015 had reduced the abundance of feral cats from 15.6/100 km in June to 7.4/100 km in August, below the necessary threshold for translocation. Consequently, in September 2015, 92 bandicoots were translocated 10 km south west of the predator-free enclosure to two release sites referred to as Site A (26° 16' S 121° 25' E) and Site B (26° 17’ S 121° 22' E) (Translocation Proposal 273). Based on the results of the previous translocation in 2012, an intensive feral cat control program was implemented prior to the 2015 translocation. Five-kilometre radius buffer zones were established around the two release sites and No. 9 Well (Figure 1: Feral management area), in which ground baiting, using 1080 Eradicat® baits, applied monthly at one bait per 100 m of track, was undertaken (Figure 1). The total area of this feral management area was 148 km^2. Leg-hold traps were also used to target individual cats when they were detected in the buffer zone. Feral cat detections were reduced to <2 animals in the 5 km buffer zone prior to the bandicoot release and maintained at this level until December 2015 (three months after release).

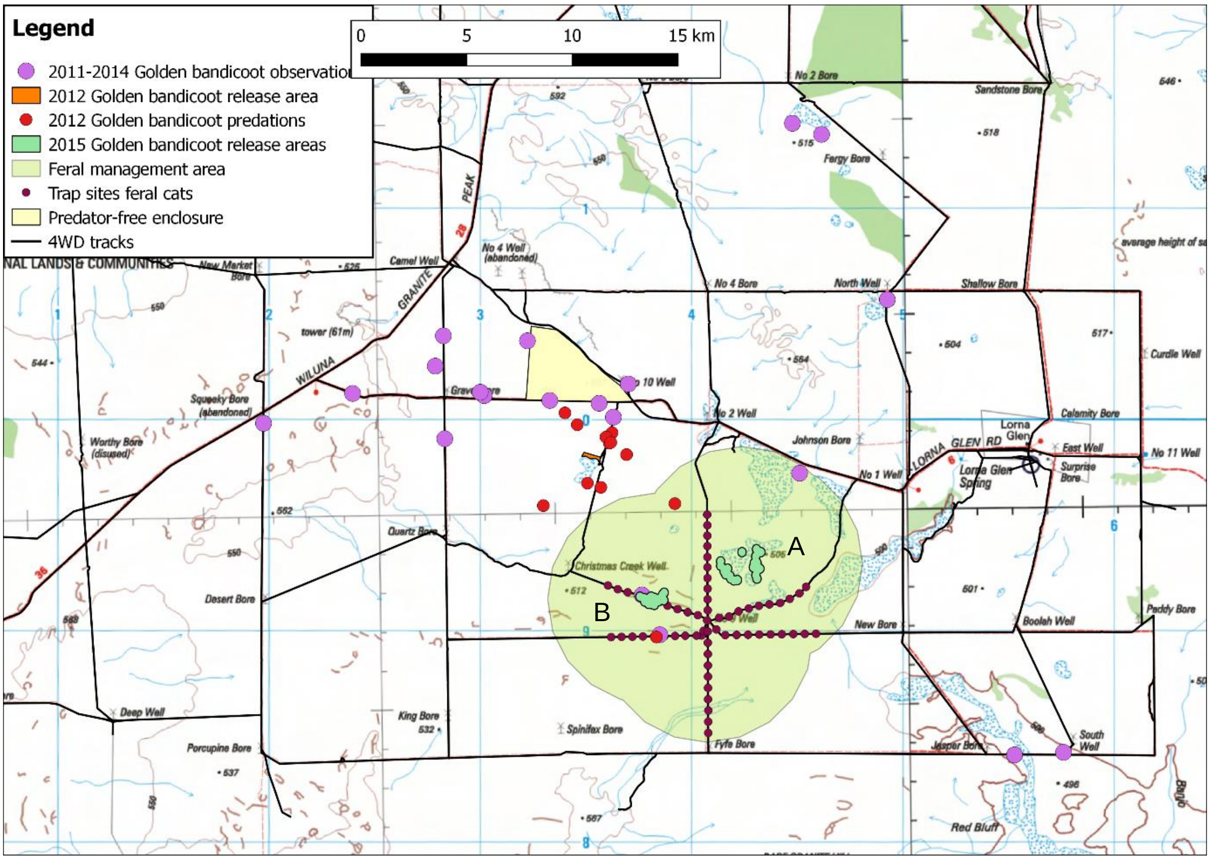

***Figure 1**. Sites where golden bandicoots were released in 2012 and 2015 in relation to the predator-free enclosure, and the feral predator management area. Release site A is east of the intersection at Well 9, and release site B is west of the intersection. Opportunistic observations of golden bandicoots prior to the translocation between 2011 and 2014 are also shown.*

Sites A and B were selected as they had similar spinifex sandplain habitat which golden bandicoots had been observed using during radio tracking work carried out in 2014 inside the predator-free enclosure. Both sites consisted of approximately 100ha of very dense spinifex (large, highly interconnected clumps of *Triodia lanigera* or *T. melvillii* surrounded by medium density spinifex sandplain made up of *T. basedowii* and/or samphire and other low shrubs) (Figure 2). Site A consisted mostly of connected large rings of *T. lanigera,* which were located along the edge of a salt-lake and calcrete ridge. The centre of Site B was situated in between two sand dunes with vegetation comprised mostly of *T. basedowii* with patches of *Aluta* *maisonneuvei* and corkwood trees *Hakea lorea*. Fresh bilby sign was often observed at the site pre and post translocation. Sites A and B were located approximately 3 km apart, a distance that provides good separation whist still within potential movement range of dispersing individuals as was determined during the previous year's radio tracking work (unpublished data) (Figure 1).

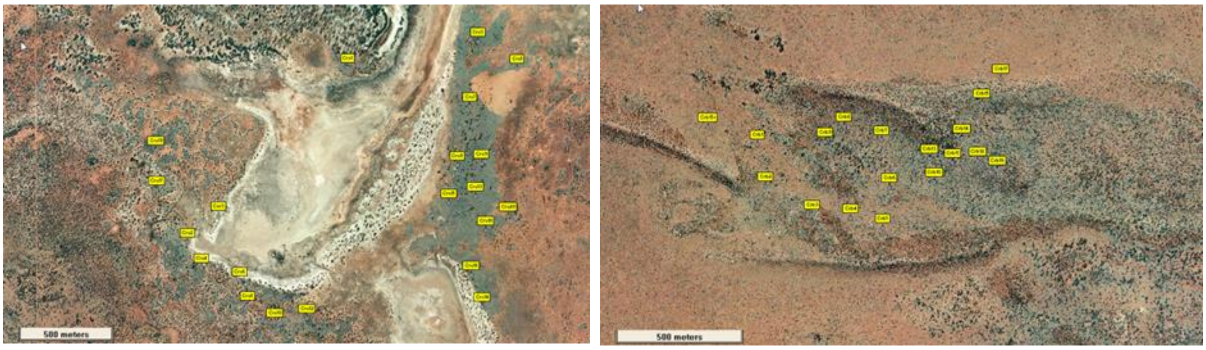

***Figure 2**. Release site A with release points of the 47 translocated golden bandicoots (left) and site B with release points of the 46 translocated golden bandicoots (right).*

Goals of the 2015 translocation

As outlined in the Translocation Proposal the three main goals were to (Sims and Morris 2015):

- Successfully reintroduce golden bandicoots to the rangelands of Western Australia
- Improve the conservation status of the species
- Contribute to the reconstruction of rangeland fauna

Success criteria

DBCA translocation proposals follow the recommendations of the IUCN Guidelines and require clear success criteria to be identified. These are the standards used to inform stakeholders on the progress of the project and provide clear benchmarks against which to judge the success or failure of the project. But equally importantly they provide clear trigger points for management action at different stages of the project. The following success criteria were developed and outlined in the translocation proposal (Sims and Morris 2015), and a summary assessment of performance against these criteria at different stages of the project is provided in *italics*.

Criteria for success of the translocation in the short term (0-6 months)

- Survival of at least 50% of the translocated released population (as measured by radio collared individuals) for two months
  - *Criteria met – only 9/31 (29%) collared animals known deceased at three months; 61% known survival rate and 10% unknown fate (Appendix 1)*
  - *Unknown survival between 3-6 months*
- Continued presence of individuals at the release location (or alternate locations that animals may move to) for 6 months (as measured by trapping and other signs [tracks/diggings/camera encounters])
  - *Criteria met – recaptures, camera encounters and tracks all present at 6 months post release albeit at dramatically reduced rates (Figure 6, Figure 10, Appendix 1)*
- No more than 15% loss before stabilisation or increasing body weights of the majority (>50%) of translocated individuals within eight weeks of release
  - *Criteria met – 30 individuals were recaptured within 8-12 weeks post release, and 84% (25/30) of individuals had increased body weight post release by 30-50% (Appendix 1)*

Criteria for success of the translocation in the medium/long term (7 months – 3 years)

- Continued presence of translocated individuals at or near release site
  - *Criteria met - Female captured and released back at Site B 10 May 2017, a period of 18 months and 14 days after this animal was translocated (animal ID GB1; Appendix 1)*
- Evidence of breeding of individuals
  - *Criteria met in short to medium term – All 26 females recaptured were carrying pouch young at 6-12 weeks post release. At least 2 females showed evidence of successful weaning of one litter and immediate birth of second litter. Nine of the ten females captured at 11-12 weeks had 3 or 4 PY respectively (most had 2 PY). Two wild bred individuals were captured 7 months post release at Site B and tracks of very small individuals were observed approximately 1 km south of Site B (Appendix 1).*
- Evidence of survival and recruitment of new F1 and subsequent generations at or near release site
  - *Criteria met in medium term – Wild male caught at Site B, 8 May 2016 (animal ID GB94). Wild juvenile female caught at Site B, 9 May 2016 (animal ID GB95; Appendix 1).*
- Dispersal of individuals to nearby appropriate habitat (tracks/signs)
  - *Criteria not met – Track monitoring indicates animals dispersing at least 2-3 km further from release areas in similar habitat, but the*

*number of bandicoot tracks rapidly reduced after November 2015 (*Figure *12)*

- Increased occurrence of records of bandicoots across Matuwa
  - *Criteria not met – Bandicoot tracks increased in occurrence in the release areas in the three months following the translocation but then decreased and remained lower 11 months after translocation. Sporadic fresh bandicoot tracks and scats have been observed as late as September 2019, 1.5 km south east of release Site B, but occur at frequencies similar to observations made in 2011-2014 prior to the translocation.*
  - *Camera captures of bandicoots increased in the two months following the translocation but then decreased rapidly. The last camera capture of a golden bandicoot was on 27 August 2017 (*Figure *6).*

Criteria for failure/triggers for action

- Greater than 70% predation of translocated or collared individuals (any feral predation events within the first 2-3 months (collar life) will trigger immediate action to kill or remove the predator – including trapping, baiting or shooting)
  - *Action triggered ~ week 3 due to dog predation of at least 4 bandicoots – dog presence reduced and predation events stopped.*
- Sustained (>4 weeks), significant (>15%) body weight loss and continuing decline, in >50% of individuals will trigger either supplementary feeding or recapture of remaining individuals and return to enclosure, depending on the assessed causes and associated environmental conditions
  - *No action triggered*
- Lack of evidence of breeding within the population
  - *No action triggered*
- No recruitment over an 18-month period
  - *No action triggered*
- Lack of evidence of animal activity (tracks/diggings/camera encounters)
  - *No action triggered*

Implementation of 2015 program

Bandicoot release

Bandicoots were trapped in the predator-free enclosure the night before the translocation and processed in an air-conditioned, two room demountable building that had been refurbished into a research laboratory. All individuals were microchipped, weighed, measured and health checked by a veterinarian. Those fitting the requirements as stated in the Translocation Proposal (i.e. individuals that were no smaller than 340g, ensuring collars remained at < 3% of body weight, and only adult animals (females with no or small pouch young (CR < 20mm)) were fitted with a Titley 2-stage mortality sensing VHF radio collar (TX GP1 PIC 3.0V custom build bandicoot collar utilizing the GP1-1/3n transmitter and Pictx54 program, with

250mm long whip aerial and 8mm wide soft leather collar, with cotton string 'weak link' weighing 9gms). The base of the whip aerial was reinforced to reduce breakage and the predicted battery life was 60 days at 60ppm, with a 12-hour duty cycle and mortality switch set to 80ppm after 12 hours (Sims and Morris 2015). Radio transmitters fitted to the golden bandicoots had a range of 1-1.5 km (Sims 2015).

Collars were fitted to animals under inhalational general anaesthesia, using a table mount Advanced Anaesthesia Specialists Stinger^{TM} anaesthetic machine with low flow vapourisor and Darvall NRB (non-rebreathing) zero dead space (ZDS) mask and T-circuit. Induction was by mask using oxygen and isoflurane at 3-5% and maintained at 1.5-2%. Duration of anaesthesia was <15 minutes and all animals were fully recovered 1-hour post induction. All animals were held in individual dark calico bags in the laboratory during the day and those that were not suitable for translocation were released back into the enclosure at dusk. All translocated animals were released after sunset at either Site A or B (Figure 1; Appendix 1).

A total of 92 (48 Male:44 Female) golden bandicoots were translocated over a 6-night period from 12-17 September 2015 (Table 1; Appendix 1).

***Table 1**. Numbers and locations of translocated golden bandicoots (M:F).*

Date	12/9/15	13/9/15	14/9/15	15/9/15	17/9/15	Total
Site A		18(9:9)	18(8:10)	4(3:1)	6(3:3)	46(23:23)
Site B	39(23:16)	7(2:5)				46(25:21)
Total	39(23:16)	25(11:14)	18(8:10)	4(3:1)	6(3:3)	92(48:44)

Feral cat control

DBCA's Western Shield Program implemented '1080' (sodium monofluoroacetate) aerial baiting for feral cats on Matuwa during the week of 6 July 2015, 68 days before the first golden bandicoot was translocated.

Prior to aerial baiting, the standardised feral cat TAI (Lohr and Algar 2020) along a 100 km transect at Matuwa was 15.6. After aerial baiting, the feral cat TAI fell to 7.4. This represented a 51% reduction in the feral cat TAI and achieved the criteria required by the Translocation Proposal of TAI<10 across the wider Matuwa area (Burrows *et al.* 2015). The method of calculating TAI consists of carrying out 3–5 repeated and sequential daily surveys of 100 km of sandy 4WD tracks, which are initially cleared of any animal tracks by towing a heavy iron drag behind a 4WD vehicle. Observers, driving all-terrain vehicles (ATVs) at a speed of 10–15 km/h then inspect the tracks for cat tracks, one hour after sunrise, and clear new signs of animal activity by towing a light-weight chain iron drag. To minimise spatial autocorrelation, cat tracks that occur within a 1 km radius of one another on a daily survey are aggregated into one feral cat detection. The number of feral cat detections are standardised over 100 km and averaged across sequential days.

In addition to the criteria of TAI<10, the Translocation Proposal also required that <2 (i.e. no more than one) feral cat be present within ~5 km radius of the release sites prior to the translocation proceeding. This was determined by daily track monitoring as described above, but within the feral management area (Figure 1). Remote infrared (IR) cameras (Reconyx™ PC900) were also deployed at 500 m intervals for 5 km along the six main radiating tracks in the feral management area (Figure 1) as an additional method of detecting feral cats in this bandicoot translocation buffer zone.

Once detected, lured leg-hold traps were deployed by qualified staff in the area of the recent tracks to remove the feral cat using methods outlined in the Standard Operating Procedure (SOP) for the Humane Operational Control of Feral Cats at Lorna Glen by Trapping and Euthanasia (Burrows and Sims 2015) and Animal Ethics Committee (AEC) #2015/11. The first feral cat was removed 27 days prior to the golden bandicoot translocation (Appendix 2).

Feral cat monitoring and trapping continued for three months after the golden bandicoot translocation, but methods varied slightly. As golden bandicoots and other non-target species could potentially be caught if traps were placed on the ground, some feral cat traps were placed onto half 44-gallon drums. The idea being that feral cats will jump onto the drums to investigate the visual, olfactory or audio lures but golden bandicoots will not. Feral cat trapping drums were placed permanently every 500 m along the tracks within the buffer zone prior to the translocation (Figure 1). Thirteen feral cats were removed between 6 August and 6 December 2015, four of these were removed prior to the bandicoot release (Appendix 2). Trapping to remove feral cats in the golden bandicoot translocation buffer zone continued opportunistically when qualified staff were on site in 2016 (Mar, May, Aug/Sept). However, trapping was hampered by rain on several occasions, and only one feral cat was successfully trapped and removed (Appendix 2).

In October 2015, Eradicat® feral cat baits containing 4.5mg of sodium monofluoroacetate (1080) were strung up to bushes along the tracks in the feral management area (Figure 1). Baits were placed at 200 m intervals, and left dangling at a height of 50 cm which prevented bandicoots from eating them but were still accessible to feral cats. Feral cats took at least two baits as evidenced by the presence of tracks. Any baits that were still hanging were removed and destroyed in November 2015 in accordance with the code of practice for the safe use and management of 1080 in Western Australia (Department of Health Western Australia 2012).

Wild dog control

Prior to the golden bandicoot translocation, no wild dogs present in the proposed release area were removed. This approach was taken based on the current theory suggesting that maintaining the presence of apex predators would help to limit mesopredator activity (Brook *et al*. 2012). However, more recent predator research at Matuwa suggests that wild dogs may not be suppressing feral cat activity (Wysong 2016). Three weeks after the translocation, wild dogs had been identified as the predator responsible for at least four of the nine known golden bandicoot deaths. On 5 October 2015 a dead, collared bandicoot was radio tracked to the entrance of a wild dog den and a second non-collared bandicoot was found a short distance away. The occurrence of predation triggered a response and wild dogs were targeted in the feral management area with 1080 dog baits. As per the baiting prescription (Application number LGSC/02/2015), baits were laid near the wild dog den and along roads within the feral management area (Figure 1). Baiting also occurred along roads that had been identified as having recent wild dog activity.

Post-release monitoring techniques

Five methods were used to monitor the translocated population of golden bandicoots and predators in the feral management area. Some techniques were used for both groups simultaneously, while others were specifically used for golden bandicoots. Below we present the methodology used, results and basic cost-efficiency assessment of each technique.

Radio tracking golden bandicoots

Radio-telemetry was used to intensively monitor survival, general movement and refuge use in one third (31/93) of translocated bandicoots during the immediate three months post-release. The top priority was to find a signal and determine the live or dead status of every animal, every day. Once this was achieved, recovery of any dead animals for post-mortem to determine cause of death was essential to allow rapid response with appropriate management actions. The secondary aim was to triangulate or track collared animals to daytime refuges, to obtain some information on movement and habitat use. The decision to constrict signal transmission to a 12-hour duty cycle (daytime hours only), was made to maximise battery life and transmission strength (prioritising functional life of the collar and maximising chance of finding elusive animals that may travel several kilometres). Unfortunately, this sacrificed the capacity to obtain home range and active movement data through night-time triangulations.

In total, thirty-one of the translocated golden bandicoots were radio tracked after release. The collars had an expected transmitting life of approximately 6-7 weeks so two groups of animals were collared and tracked to enable monitoring of the translocation over a three-month period. Between 12-15 September, at the time of the initial release, twenty-four (11 Male and 13 Female) bandicoots were collared. Twelve bandicoots that were still carrying collars after six weeks were recaptured and had their collars removed. Between 17 and 27 October, seven additional translocated bandicoots were recaptured, fitted with collars and released again. The necks of all animals were in good condition with very little sign of irritation at collar removal. However, none of the remaining originally collared animals were recollared in October, as most were females, which were now carrying pouch young (>20mm) by this time. All these animals were recaptured 30-50 days later and had their collars removed before being released again.

An R1000 148-174MHz Telemetry receiver connected to a large 7-element Yagi antenna atop a pneumatic portable mast (Clark Mast PT), fitted to the tray of a utility vehicle was used to locate signals from collared individuals daily (Figure 3). The tower was extended using a 12V air compressor powered by the vehicle. It was able to be rotated by the operator to determine the direction of the radio collared animal. Where possible, individuals were then tracked to their diurnal refuge on foot using a handheld 3-element Yagi antenna (Appendix 1). When a mortality signal was detected, the animal was immediately located, and a mortality report detailing faunal remains and any sign of predation was completed. A plane was used to locate collared individuals that could not be found from the ground on the 25th of September (when 22 of the 24 signals were located) and again on 25th and 26th of October to locate the twelve remaining collared individuals. The last collar was removed on the 7th of December 2015 (Appendix 1).

Figure 3. Adrian Wayne, Keith Morris, Kimberley Page and Frank Morris radio tracking golden bandicoots using the large Yagi antenna fitted to a telescopic ClarkMast.

Nineteen of the thirty-one collared bandicoots remained alive up to collar removal, nine were killed during the period they were radio-tracked and three were lost with their fate unknown (Table 2). One uncollared translocated bandicoot was killed and found near a dead collared bandicoot. The lost animals may have been as a result of factory failure of collars, damage sustained to collars or a movement by the individual out of detectable range. As collars were fitted with a weak link system, it is expected that they would have eventually fallen off the lost bandicoots.

***Table 2**. Survivorship of released animals at three months.*

Site	Date collared	Date collar removed	Collared (M:F)	Dead	Lost	Alive and collar removed
A	13–15 Sept 2015		12(5:7)	5	2	5
B	12–15 Sept 2015		12(6:6)	4	1	7
A	18-29 Oct 2015		3(3:0)	0	0	3
B	18-29 Oct 2015		4(3:1)	0	0	4
Total			31	9	3	19

The individuals that were killed, were swabbed to determine the species of the suspected predator. Testing was conducted by Helix Solutions in Western Australia, who compared DNA taken from bite marks on the body or collar of the bandicoot to known samples in their laboratory. Four of the dead bandicoots had dog DNA on them and one had cat DNA presumably from the saliva of the predator. The other three carcasses sampled failed to provide suitable DNA to match to reference materials, and at least one of these was suspected (based on tracks and type of injuries) of being raptor predation.

Evidence such as tracks, camera images and the location of a wild dog den nearby suggests that kills made by wild dogs, may have been done by a female and/or young sub-adult pups that were engaging in killing bandicoots, possibly for hunting practice as the bandicoot carcasses were not generally eaten. All suspected wild dog kills occurred over a 10-day period, which triggered a response to remove wild dogs from the area. This action put an end to the killing and had intervention been delayed in order to wait for genetic analysis, it is possible that more bandicoots could have been killed.

Most of the radio-tracking occurred within the feral management area (Figure 4). The points on Figure 4 represent the reference locations from which a bandicoot's collar could be detected. Search points were generally selected along vehicle tracks from which the strongest and most reliable signals from collars could be detected and were used to minimise time required to obtain 'live' or dead' signals.

Search points were often located at high points or where there were no dunes interrupting lines of sight between the tracker and the collars. Based on prior tests of collar transmission distance, the bandicoot could be up to 1.5 km from this point, although some individuals were regularly located very close (within 50 m) to the roads. The exact location of the bandicoot associated with these points is usually not known as radio-trackers were often only able to collect information on the presence of live/dead signals each day. This was due to some highly mobile bandicoots requiring extensive periods of searching to relocate their signals. Trackers usually only honed-in on a bandicoot when a 'dead' signal was detected, and a carcass needed to be retrieved (Figure 4). However, whenever time allowed, bandicoots that were close to the roads were tracked to their daytime refuge which provided information on refugia and habitat selection. No attempts were made to estimate the location of individuals using triangulation methods (Berg 2015).

A total of 82 refuge locations were recorded for thirteen of the 31 radio-collared individuals. These ranged from one to twenty locations per animal. Most (>90%) were obtained from the second half of the three-month tracking period and showed that at this stage some animals were still moving over 1.5 km between refuges, whilst others were moving less than 300 m between refuges.

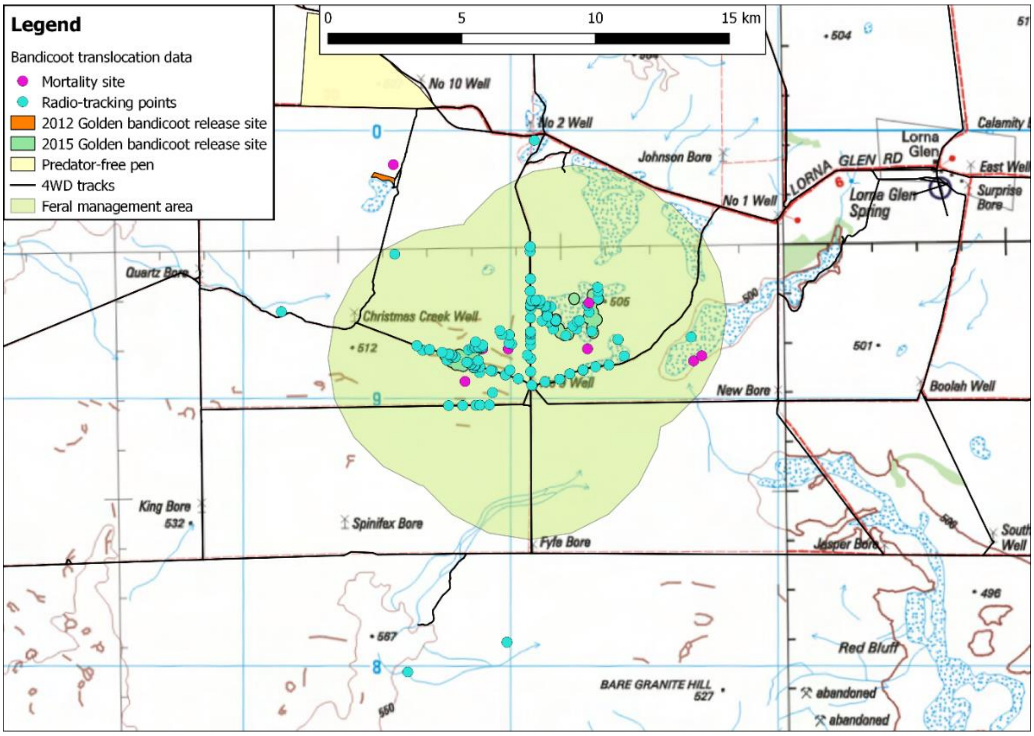

Figure 4. Depiction of the radio-tracking data points collected from golden bandicoots in the three months after the translocation of bandicoots from the predator-free pen in the Matuwa Indigenous Protected Area.

Assessment of the time-efficiency of radio-tracking

A team of at least two people were on site to radio track every day from first release (12 Sept 2015) to last collar off (20 November 2015). Each team had at least one day to handover to the next.

9 teams over 69 days

69 days plus 9 handover days = 78 days radio-tracking

Four hours for each 78 radio tracking days = 312 hours

2 people @ 312 hours = 624 person-hours

894 radio tracking data points providing live/dead signal, coordinates of reference point, bearing and signal strength

894 data points/624 person-hours = **1.43 data points per person-hour**

Remote cameras

Remote cameras were deployed across the two release sites to provide information on persistence over time and local dispersal of bandicoots from original release locations. In addition, images can help to provide limited information on breeding and recruitment in the population. Cameras also have the capacity to simultaneously identify presence and activity of predator species in the area, and the 'off-track' camera placement provided an adjunct to predator information available from track monitoring based solely on roads.

A grid of 42 unbaited, Reconyx PC900 Hyperfire Professional Covert camera traps was established to help monitor the translocated golden bandicoots (Figure 5). The cameras were mounted onto sand pegs at a height of 20 cm, deployed in the first week of September 2015 and remained in place until December 2017. SD memory cards and batteries were replaced regularly throughout this time. Cameras were spaced 1 km apart, with three extra cameras placed within 2 km of the release sites. Cameras were positioned facing south with at least 2 m of bare earth in front of them to prevent non-target triggers of vegetation. Each camera was programmed with the 'Aggressive pre-setting mode' (5 images taken at rapid fire with no quiet period between triggers). In total, 112,196 images were taken and stored in a Colorado Parks and Wildlife Photo Warehouse database (Ivan and Newkirk 2016) for analysis.

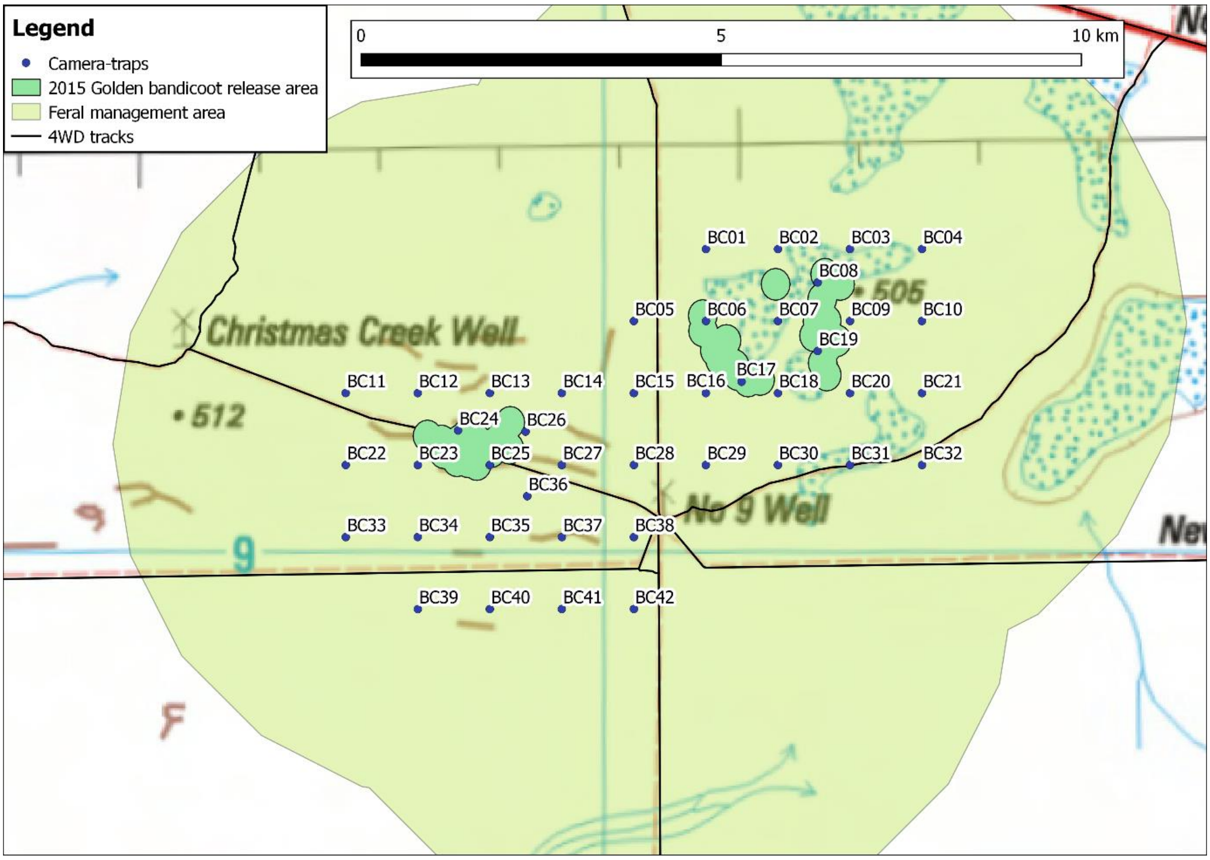

***Figure 5**. Locations of 42 camera-traps used to monitor translocated bandicoots.*

Data from the camera-traps show a decreasing capture rate of bandicoots over time, with no bandicoots captured on the cameras since 27 August 2017 (Figure 6). Wild dogs (Figure 7), feral cats (Figure 8), and rabbits (Figure 9) were also detected. Dogs were consistently present throughout the monitoring period. Peaks in the number of photos of feral cats appears to be highly correlated with the number of photos of rabbits, though no analysis has been performed to confirm that observation.

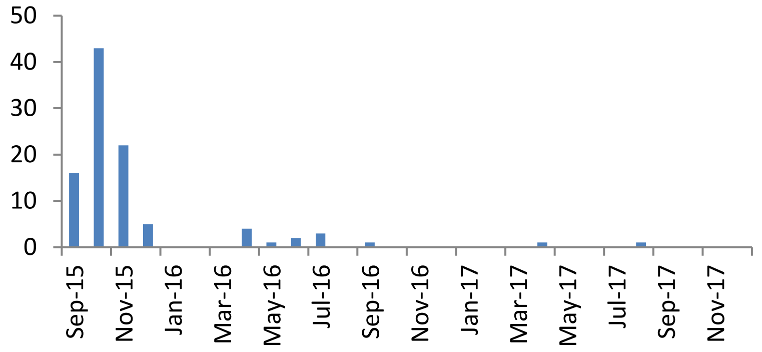

Figure 6 *Number of camera-trap captures of golden bandicoots over time in the feral management area.*

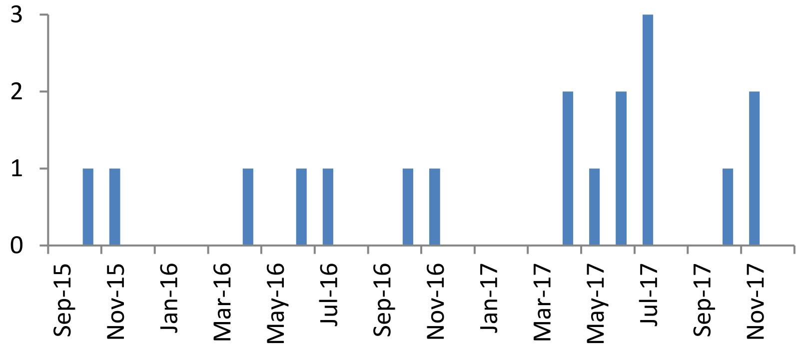

Figure 7 *Number of camera-trap captures of dogs over time in the feral management area.*

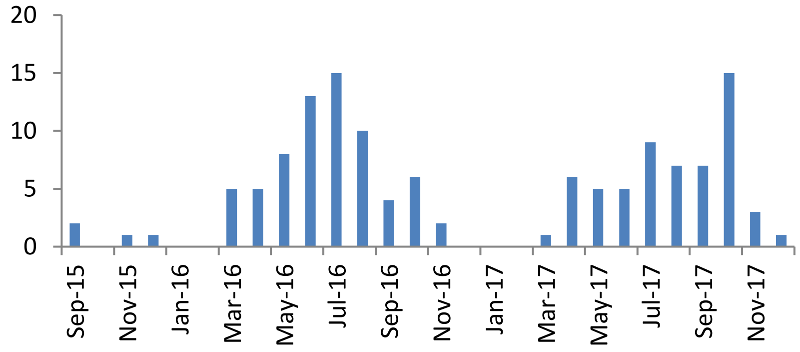

Figure 8 *Number of camera-trap captures of cats over time in the feral management area.*

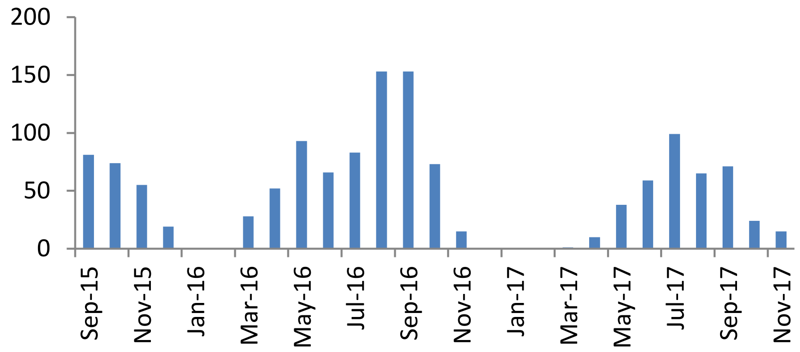

Figure 9 *Number of camera-trap captures of rabbits over time in the feral management area.*

Assessment of the time-efficiency (person-hours per data point)

7 trips each taking 3 days with at least 2 people

8-hour days x 3 days = 24 hours

24 hours x 2 people = 48 person-hours

7 trips at 48 person-hours = 336-person hours

94 photo captures of golden bandicoots

94 photo captures / 336-person hours =

0.27 data points per person-hour (not including image management time)

Track monitoring

Track monitoring was used to help identify both persistence and dispersal of bandicoots during and after radio-telemetry, along with the presence and activity of predators in the same areas.

After the translocation, track monitoring for feral cats and golden bandicoots within the feral management area occurred over seven discrete sessions with a total of 24 days of monitoring. Several days of track monitoring occurred whilst trapping for feral cats. The number of tracks seen per day for each of the three months was averaged. Track monitoring across the wider property as per the TAI prescription occurred in March and May 2016.

Across the wider property, feral cat TAI fluctuated between 10-15/100 km (Figure 10). In 2015, the abundance of feral cats decreased from 15.6/100 km in June to 7.4/100km in August, in response to the annual aerial baiting conducted by DBCA's Western Shield program. Within the feral management area where additional feral cat control methods were employed feral cat numbers were typically less than 8/100 km.

On average, eight sets of golden bandicoot tracks were observed per day in October 2015. That number decreased to two sets of tracks per day in December. Golden bandicoot tracks were still being observed in August 2016 (Figure 10). The number of bandicoot tracks rapidly reduced after November 2015 (Figure 10) and coincided with an apparent increase in the number of feral cat tracks. Golden bandicoots were still being captured on camera-traps at this time (Figure 6).

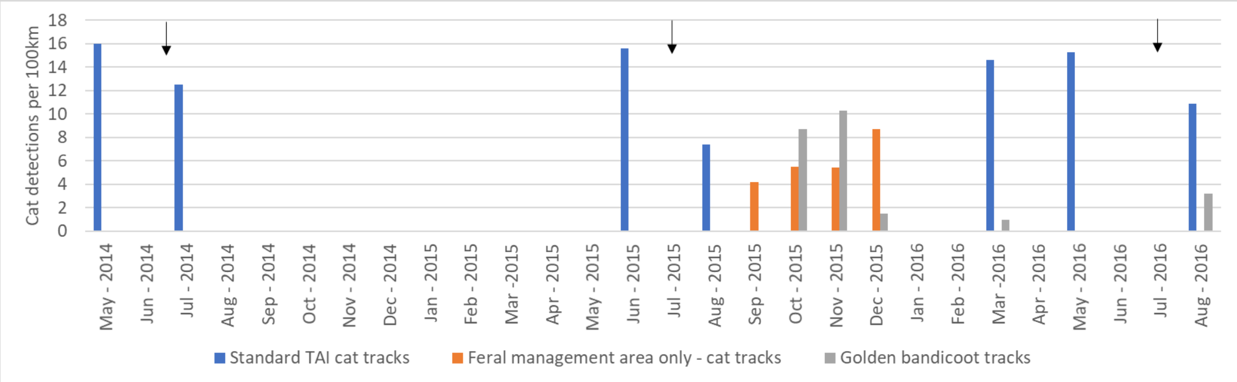

Figure 10 *Bar chart depicting the number of tracks (TAI) for feral cats and golden bandicoots collected during either standard pre-bait/post-bait TAI surveys or during surveys in the feral management area shortly after the golden bandicoot translocation. Arrows indicate aerial baiting events.*

Assessment of the time-efficiency (person-hours per data point)

Within the feral management area - After an initial drag with a vehicle, tracks are checked and dragged daily by 1 person on a quad bike.

7 days initial drag plus 24 days TAI at 4 hours per day = 124 person-hours

153 bandicoot tracks were recorded over 124 person-hours

1.2 golden bandicoot detections per person-hour

Trapping

Trapping was employed to provide survival, location, health and reproductive information on all founder individuals post translocation, in addition to capturing and identifying new recruits.

Five trapping sessions of three nights each occurred at release sites A and B after the collars were removed from the golden bandicoots. Sheffield small cage traps (~31 x 31 x 70cm) covered with shade cloth were used and baited with peanut butter and rolled oats.

A total of 29 golden bandicoots were trapped at the release sites A and B in the 18 months following the translocation (Table 3). Two new, apparently wild born, individuals were captured at Site B in May 2016. Three founder individuals (two females and one male) were trapped at Site B more than six months after their translocation (Appendix 1). Nearly all recaptured bandicoots had gained weight between the translocation and recapture at the release sites (Figure 11) with an average of 43% gain in weight by October 2015. Only one individual, who had produced two litters of young (GB36) had lost weight (20g) between the translocation in September and 26 October 2015 (Appendix 1).

Table 3. Numbers of bandicoots trapped during post release monitoring.

Location	Date	Trap nights	Number of captures	Capture rate %	Individuals	New individuals
Site A	Dec 2015	183	13	7.1	12	0
Site B	Dec 2015	150	8	5.3	4	0
Site B and surrounds	Mar 2016	72	2	2.8	1	0
Site A	May 2016	180	0	0	0	0
Site B and surrounds	May 2016	228	5	2.2	3	2
Site A	Aug 2016	180	0	0	0	0
Site B and surrounds	Aug 2016	498	0	0	0	0
Site B	May 2017	135	1	0.7	1	0

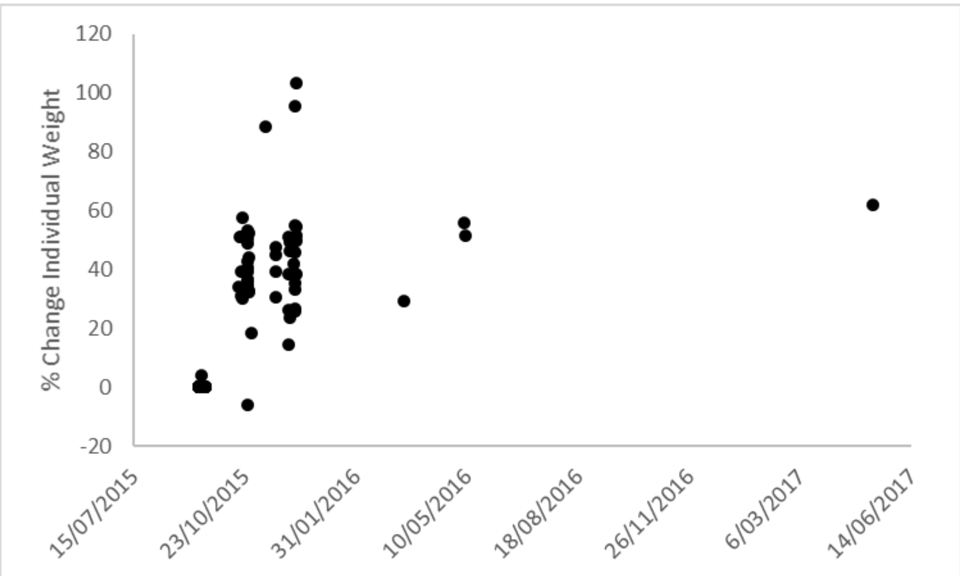

Figure 11. Percentage change in the body weight of individual golden bandicoots between weight at translocation and weight at recapture.

Assessment of the time-efficiency (person-hours per data point)

8 trapping sessions over nights each = 24 nights

2 people per session over 24 nights = 48 nights

Five hours per night to set and check traps = 240 hours

21 individuals captured over 240 hours

0.08 individuals trapped per person-hour

Two-hectare track plots with Matuwa Kurrara Kurrara Rangers

Two-hectare plots were an additional track monitoring technique that provided information on wider presence and dispersal of bandicoots across the broader Matuwa landscape, away from the immediate release and management area.

In late 2015 (post-translocation) golden bandicoots were detected on four out of twelve 2-ha track plots surveyed by Matuwa Kurrara Kurrara (MKK) Rangers. In September 2019, thirty 2-ha track plots were surveyed over 3 days as per the standard track plot protocol used for species such as bilbies (Southgate *et al.* 2005). One definite golden bandicoot scat and two possible golden bandicoot tracks in 2019 were detected (Figure 12). The scat was found 1.7 km south of release Site B and its identity was confirmed through comparison to known scats held in the laboratory. The limited number of detections four years after the translocation provides some evidence of long-term persistence of golden bandicoots on Matuwa, but given the anecdotal observations of bandicoots between 2011 and 2014 (Figure 1), does not support the long-term success criteria for the translocation.

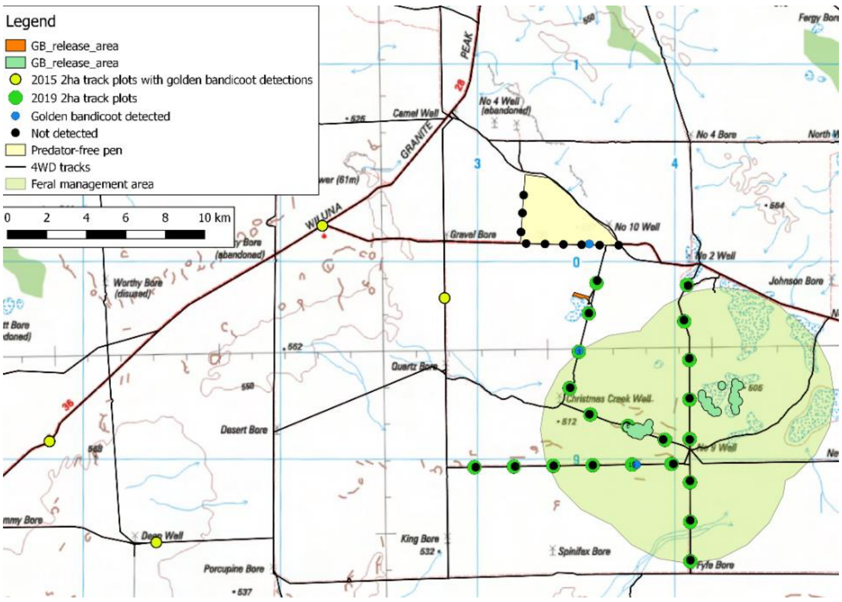

Figure 12 *Detections of golden bandicoots on Matuwa using 2-ha track plot protocol and working with Matuwa Kurrara Kurrara Rangers. Some of the proposed track plots sites (green) were not surveyed for cultural reasons.*

Assessment of the time-efficiency (person-hours per data point)

6 observers over 3 days = 18 days

Five hours per survey = 90 hours

3 individuals observed over 90 hours

0.03 individuals recorded per person-hour

Comparing different monitoring techniques

Monitoring and managing a translocation requires the collection of information on both short-term survival and health of translocated individuals, as well as longer term information on health, reproduction, recruitment, persistence and dispersal. Monitoring newly translocated individuals presents specific challenges. Five methods were used to monitor the population of translocated bandicoots (Table 4), each with its strengths and weaknesses.

Radio-tracking can provide high quality data on the location and survivorship of the bandicoots but can be very labour intensive particularly if triangulation methods are used to estimate the location of animals (Berg 2015). Ethically, transmitters must be less than 3% of the body weight of the tracked animal, which for golden bandicoots means they must be less than 10g in weight. While solar-power transmitters are lighter, golden bandicoots are nocturnal and cannot be tracked reliably with solar-powered transmitters. GPS transmitters are typically heavier than 10g and would still need to be paired with trackable VHF/UHF mortality sensing units to be able to monitor survival in real time. New tracking devices with a longer battery life and/or automated receiving equipment are available, but those under 8g generally still do not have a ‘mortality’ function. The mortality function was a feature considered critical for this translocation as it enabled rapid recovery of dead animals. This helped determine the cause of death and facilitated the implementation of early management actions.

Remote camera-traps can provide information on species presence and reproduction (Figure 13) but generally not individual survival. They vary greatly in terms of quality and price, with the higher end cameras used in this translocation costing approximately $1000AUD per unit. Remote cameras have the advantage of providing near constant surveillance with high quality verifiable data and relatively minimal fieldwork. However, classifying the images is time-consuming. Digital platforms such as eMammal and Zooniverse have been created to facilitate citizen science involvement in camera-trap surveys (McShea *et al.* 2016; Simpson *et al.* 2014). Batches of images can also be exported from CPW Photo Warehouse for classifying by volunteers without the need for a digital platform and associated costs (Ivan and Newkirk 2016). It is unknown how robust camera-traps are to false negatives, i.e. failing to capture a photo of a golden bandicoot when present. It should also be noted that operating specifications of some remote cameras, due to their heat-differential sensor triggers, suggest that high ambient temperatures (e.g.

>55ºC daytime and >30ºC at night) may result in some variable level of function. High ambient temperatures may also affect battery life.

Figure 13. Photo of an unidentified female golden bandicoot with pouch young captured at Matuwa at camera-trap BC17 (Figure 5) on the 17 November 2015.

Track monitoring and 2-ha track plots are both rapid survey techniques that provide data on the presence of a species (Southgate *et al.* 2005). These techniques do not provide data on the health, survivorship, or reproduction but may provide some information on recruitment if the tracks of young individuals are detected. The start-up costs are low compared with the other monitoring techniques, but some level of expertise is required to identify animal tracks.

Track monitoring or the standard TAI requires the use of an ATV and training certification for observers. Tracking techniques may provide quantifiable data if collected with tracking tunnels and ink pads. Reportedly, trapping is 29-46 times more expensive than chew-track-cards in large scale surveys (Sweetapple and Nugent 2011). Trapping, however, provides more detailed data on the health, survivorship, and reproductive status of individual translocated animals than the other four monitoring techniques. Trapping may become a very labour-intensive and inefficient monitoring technique to use when dealing with highly mobile species (Figure 4). The number of traps set and their location in the landscape is also limited by the ability of staff to clear them in a timely and ethical manner as stipulated by regulatory authorities. Practitioners need to balance the need for detailed data with associated labour costs.

Table 4. Comparison of the five monitoring techniques used during the 2015 translocation of golden bandicoots from the predator-free pen at Matuwa to the wider landscape.

Detection method	**Time-efficiency**	**Quality data**	**Translocation criteria**	**Strength**	**Weakness**
VHF radio-tracking	1.43	High	Short term	Data on survivorship, location, habitat use, identify cause of mortality	Intensive fieldwork; limited locational data without triangulation
Remote cameras	0.27	High	Short & medium	Constant observation; limited fieldwork, some data on reproduction	Intensive office-work; limited survey points; likely false negatives; expensive equipment
Track-monitoring	1.2	Medium	Short, medium & long	Rapid survey technique	Presence only data
Trapping	0.08	High	Short term	Data on survivorship, reproduction, health	Intensive fieldwork; requires skilled staff; limited survey points
2-hectare track plots	0.03	Medium	Short, medium & long	Rapid survey technique; culturally appropriate work for Aboriginal Rangers	Presence only data

Survivorship and causes of mortality

Radio-tracking and trapping were the only monitoring techniques used that could provide data on the survivorship of released animals. Radio-tracking suggested that at least 19 out of 31 (61%) of released animals survived for three months after the translocation. There was a 29% mortality rate and the fate of 10% of individuals was unknown. During trapping, three translocated individuals were captured approximately 6 months after translocation and one individual was captured 18 months after translocation. Of the ten known deaths in the three months post release, eight (80%) were believed to be due to predation and two (20%) were due to misadventure.

One bandicoot was caught in a feral cat trap and had to be euthanised, one was caught in a hollow tree (not due to collar), four were confirmed to be wild dog predation and one confirmed to be feral cat predation. Three other deaths were presumed to be from predation, but the identity of the predator could not be confirmed by DNA analysis. However, evidence from track and injury type suggested one was a wild dog, one a raptor and one unknown. All five dog predations (50% of known mortalities) occurred within a 10-day period and ceased once wild dog control was instigated.

Kealley (2016) investigated the relationships between laboratory measures of stress, practical field assessments of handling behaviour and field survival post release for the 2015 translocated golden bandicoots to determine the best suited individuals for translocation. This was based on a behavioural score from 1-4 (calm - aggressive), morphometric and condition data and levels of cortisol in faecal samples. The results indicated no relationships between behavioural score and body condition, behavioural score and faecal cortisol concentration, or behavioural score and mortality. There was a correlation between body condition and mortality in that individuals with a higher initial body condition had a higher rate of mortality. It was suggested that larger bandicoots ranged further so were more likely to cross paths with feral predators. This may also be a result of body size being correlated with sex (i.e. larger animals are generally males which tend to have larger home range sizes and longer maximum travel distances). Five of the eight known mortalities attributed to predation events were male individuals.

While there was medium-term survival of some founders, the long-term survival of translocated individuals and their progeny could not be confirmed as trapping became an increasingly inefficient method of monitoring the bandicoots as their density in and near the release sites declined. It was evident, however, that some translocated golden bandicoots could survive in the presence of a suppressed population of feral predators (Lohr and Algar 2020). It is possible that the decline in bandicoot density was due to lack of recruitment in the presence of feral predators; as was the case in the translocation of western barred bandicoots at Heirrson Prong Western Australia (Short 2016). Additionally, episodic drought, which occurred at Matuwa between 2017 and 2019, may have intensified the impact of predation by restricting reproduction of prey species (Short 2016).

Evidence of breeding

It appears that the translocated bandicoots started breeding as soon as they were released. All 26 females recaptured 6-12 weeks post release were carrying pouch young and at least two females showed evidence of successful weaning of one litter and immediate birth of a second litter (Appendix 1). Nine of the 10 females captured at 11-12 weeks post release had three or four pouch young (Appendix 1). Early evidence of breeding post release indicates that the translocation did not suppress reproduction and indicates that the chosen habitat for release was of good quality.

Two wild (not translocated) bandicoots were captured at Site B over seven months after release in 2016. The first of which was a male weighing 640g and the second was a small female weighing 125g (Table 5). It is possible that the large male (GB94) was not the progeny of a translocated female but rather a pre-existing wild male.

Small bandicoot tracks were observed at Site A in May 2016 indicating breeding had occurred there too. These were not included in Figure 10 as they were off the search track.

Breeding could be not confirmed in the long-term due to lack of captures.

Table 5. Wild born bandicoots

Site	Date captured	Animal id	Pouch young	Weight
B	8 May 2016	GB94		640g
B	9 May 2016	GB95	0	125g

Dispersal

A collared male (Animal ID GB18) that disappeared within 2 weeks of release and was later located by air approximately 10 km south of its release site, was recaptured back at Site B over two months later, still carrying its radio-collar and in much better condition, having gained 51% body weight. Most of the bandicoot detections in 2016 occurred within the feral management area with four animals moving 10-20 km from the site (Figure 14).

The medium to long-term success criteria of individuals dispersing to nearby suitable habitat cannot be confirmed as detectability dramatically declined three months after the translocation. Animals that were trapped or tracked 18 months after the translocation were detected near the release sites. Detections of bandicoots in 2019 could be from translocated individuals and their progeny or from bandicoots that escaped the predator-free pen.

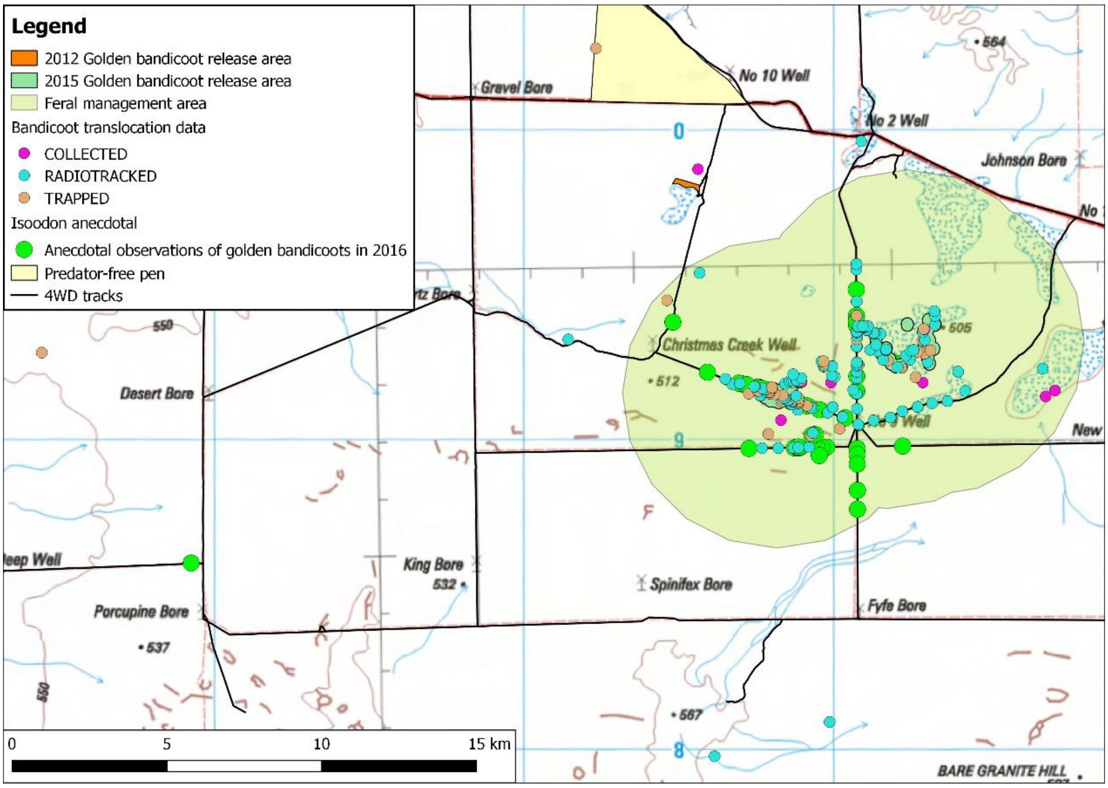

***Figure 14** Map showing observations of golden bandicoots on Matuwa during (radio-tracked) and after (trapped and anecdotal) the translocation.*

Predator activity

Intensive predator control was implemented for three months during and after the translocation of golden bandicoots. The observed level of feral cat activity decreased from 15.6 to 7.4/100 km in response to Western Shield's annual aerial baiting. Feral cat activity decreased further to 4/100 km in response to leg-hold trapping prior to the translocation. Feral cat numbers then increased from 4 to 8.5 cats/100 km in the three months after the translocation (Figure 10). Similarly, TAI data for dogs suggests that targeted ground baiting reduced the level of wild dog track activity from an average of two per day in the first week of October to one per day in mid-November. While camera-trap data does not verify this result, the predation of collared bandicoots stopped after targeted baiting was implemented.

Feral cats and wild dogs were only intensively managed in the feral management area (Figure 1). The average diameter of a feral cat or wild dog's home range (from 95% KDE) on Matuwa is 2.1 km and 14.7 km, respectively (Wysong 2016). Both feral cats and dogs are known to engage in long-distance forays well outside of their core home-range (Moseby *et al.* 2009). Reinvasion into the feral management area would have been rapid, especially since the TAI across the wider property suggests that annual aerial baiting was maintaining feral cat density at 10-15/100 km (Figure 10).

In the future, it is recommended that intense predator control (Lohr and Algar 2020) occur over a much larger area before, during and after fauna translocations until multiple sequential predator surveys (TAI) of the whole property suggest that the suppression of feral cats below 10/100 km is being sustained. Due to wide error margins of the TAI (Lohr and Algar 2020), a single data point indicating that feral cat numbers fell below the translocation threshold between 2014 and 2016 (Figure 10) is probably insufficient evidence to support a translocation proposal. This drop is likely to have been temporary due to reinvasion of feral cats from neighboring properties (Algar *et al.* 2013).

It has also been demonstrated that the survival rate of translocated fauna is typically lowest in the first three months after translocation (Moehrenschlager and Macdonald 2003; Jones and Witham 1990; Pinter-Wollman *et al.* 2009). It is therefore paramount that intensive predator control occurs daily for a least three months post translocation while the animals are establishing a new territory. In this translocation, intensive predator control was employed in the core release area for the first three months, but it proved insufficient on its own to allow for the establishment of the new bandicoot population beyond the initial three month period. For this reason, predator control should probably extend over a much larger area than the feral management area used during this translocation and be maintained for a significantly longer period-of-time, if not in perpetuity. This has significant implications for the logistical and financial costs of maintaining the required level of predator control for the extended time needed to achieve a successful translocation. There are also particular challenges associated with effectively employing the various control measures in the presence of nationally listed threatened species and other susceptible non-target species.

Conclusions

Major challenges

Conducting conservation work in remote areas has considerable challenges. The primary challenge is associated with the cost of maintaining a constant staff presence on site to respond to native animal mortality.

The ability to address many of the medium- and long-term criteria for success was compromised by the reduction in the level of monitoring of the translocated bandicoots, which declined dramatically after the radio-tracking collars were removed. Camera-traps were the only monitoring tool that continued until November 2017, and the data from those suggest a gradual decrease in the size of the bandicoot population over time. Track monitoring in the feral management area did not continue in 2016, and trapping was limited to four sessions. The high cost of working in remote areas places limitations on the level of ongoing monitoring post-translocation.

Maintaining predator control where reintroduced and other non-target animals are present requires measures to reduce non-target impacts. In this instance, the most effective feral cat trapping method used, namely ground set leg-hold traps, could only be used sparingly, and food-based lures that may attract bandicoots to the trap were unable to be used. Similarly, the use of 1080 baits was somewhat restricted due to the risk to bandicoots (Lohr 2019). Non-toxic baiting trials within the predator-free pen at Matuwa suggest that 42% of bait encounters by bandicoots will result in the bait being taken. Golden bandicoots have an LD_{50} to 1080 of 9 mg/kg (Twigg and King 1991; Twigg *et al.* 1990), suggesting that average sized animals (260-650g) may succumb to 1080 poisoning if they consume 0.5-1.3 ERADICAT® baits. Hence, baits were hung from branches to prevent bandicoots accessing them. Some baits were taken by non-target species such as brushtail possums (*Trichosurus vulpecula*) and emus (*Dromaius novaehollandiae*). The mitigation measures and removal of baits by non-targets all reduce the effectiveness of predator control. It is recommended that specialised staff, highly skilled in predator control with experience working around non-target species, be engaged during translocation projects.

Major lessons learned

- As wild dogs were identified as a significant predator (in the presence of feral cat control) of the translocated bandicoots, their removal before the translocation may have helped it to succeed. Wild dogs were also identified as the main predator of boodies and bilbies translocated to the open landscape at Matuwa (Lohr 2019). While it is currently popular to assume that maintaining apex predators within the environment can be beneficial to vulnerable native fauna (Allen *et al.* 2011; Cooke and Soriguer 2017), our observations suggest that wild dogs can be a direct threat to native fauna, especially during a translocation.
- The low level of confirmed feral cat predation indicates that the intensive feral cat control program before and directly after release was effective. However, the rapid drop in detectability of bandicoots, and the increased number of feral cat detections after this period indicates this effectiveness was not maintained.
- A relatively short period of intense predator control prior to a translocation and during the first 11-12 weeks after a translocation is not sufficient to allow successful establishment of a high-risk translocated species in the longer term at Matuwa, even with moderate levels of cat control (TAI maintained at 10-15/100 km) through annual aerial baiting programs.
- Selection of release sites informed by radio-tracking data from within the predator-free enclosure was valuable as it provided information on likely habitat utilisation and potential movement distances and patterns of golden bandicoots.
- Collaring and release techniques were appropriate as all measures (survival, body weight, condition, reproduction) indicate that most of the animals did not suffer from ill effects of translocation.
- Where-ever possible, radio-tracking should continue for longer than just the 3-month period in which the survival rate of translocated fauna is known to be lower. Ongoing radio-tracking could be used to confirm whether translocated individuals have established a new territory and whether predation increased after intense predator control ceased.

Success of translocation

Very successful	Successful	Partially successful	Failure
		✓	

Reasons for success

- Pre-translocation testing of transmitter technology and telemetry studies of home range, movement and habitat use provided valuable data to inform selection of suitable release sites and designing release and monitoring protocols.
- Early and persistent feral cat control during the translocation of golden bandicoots coupled with the annual Western Shield aerial baiting program across the property over 10 years was likely to have facilitated the short-term success of the translocation.

Reasons for failure

- The correlation of increasing predator presence with declining bandicoot presence after three months is highly suggestive of predation being the likely cause of failure of the translocation in the longer term.
- Intensive feral cat control was limited to the feral management area and ceased too early.
- Wild dogs were not controlled before the translocation.
- The risk to translocated species and other non-target species from feral cat control techniques compromised their on-going effectiveness.

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Appendix 1 Golden Bandicoot translocation data

Golden bandicoot (*Isoodon auratus*) capture and radio tracking data is available on the DBCA internal Data Catalogue at https://data.dpaw.wa.gov.au/dataset/translocation-of-golden-bandicoots-out-of-pen-at-matuwa-ipa [accessed 28 July 2020].

Appendix 2 Feral predator data

Feral cat trapping data

Common name	Species	Sex	Closest drum trap	Lat	Long	Position of trap	Lure	Date	Fate
Feral Cat	Felis catus	Female (3 fetuses)	E8a	-26.30308	121.44524	Ground	Tweeter	18/08/2015	Shot in trap
Feral Cat	Felis catus	Male	NW04a	-26.29031	121.38583	Ground	Cat scat and urine	25/08/2015	Shot in trap
Rabbit	Oryctolagus cuniculus	Unknown	E3a	-26.30315	121.4184	Ground	Cat scat and urine	26/08/2015	Shot in trap
Bird	Unknown	Unknown	E4a	-26.30313	121.4238	Ground	Tweeter	26/08/2015	Predated while trapped
Rabbit	Oryctolagus cuniculus	Unknown	N8a	-26.260575	121.4051	Ground	Cat scat and urine	29/08/2015	Shot in trap
Feral Cat	Felis catus	Male	SS10a	-26.34488	121.40435	Ground	Tweeter, bird feathers and remains of rabbit carcass	1/09/2015	Shot in trap
Rabbit	Oryctolagus cuniculus	Unknown	EE04a	-26.30313	121.4238	Ground	feathers and tweeter	1/09/2015	Shot in trap
Feral Cat	Felis catus	Male	EE04a	-26.30313	121.4238	Ground	Cat scat and urine	2/09/2015	Shot in trap

Sand Goanna	Varanus gouldii	Unknown	E4a	-26.30313	121.4238	Ground	Tweeter	12/09/2015	Euthanased
Bilby	Macrotis lagotis	Female	N2a	-26.287758	121.404847	Ground	Cat scat and urine	12/09/2015	Treated and later died in care
Wild Dog	Canis familiaris	Unknown	N8a	-26.260575	121.4051	Ground	Cat scat and urine	13/09/2015	Escaped, destroyed trap
Feral Cat	Felis catus	Male	E7a	-26.30308	121.43984	Ground	Goanna blood	14/09/2015	Shot in trap
Feral Cat	Felis catus	Male	E8b	-26.30308	121.44524	Ground	Cat scat and urine	15/09/2015	Shot in trap
Golden Bandicoot	Isoodon auratus	Female	N7b	-26.265013	121.405045	Ground	Cat scat and urine	16/09/2015	Sent to carer (Kanyana) Euthanased
Western Bowerbird	Chlamydera guttata	Male	NW1	-26.29452	121.40013	Drum	Tweeter and cat scat	21/09/2015	Euthanased
Brush-tail Possum	Trichosurus vulpecula	Male	NE9	-26.28569	121.44838	Ground	Cat scat and urine	24/09/2015	Released OK
Feral Cat	Felis catus	Male	N9	-26.25613	121.405166	Ground	Cat scat and urine	7/10/2015	Shot in trap
Feral Cat	Felis catus	Male	E4a	-26.30313	121.4238	Ground	Cat scat	11/10/2015	Shot in trap
Brush-tail Possum	Trichosurus vulpecula	Male	N9a	-26.25613	121.405166	Ground	Cat scat and urine	15/10/2015	Released OK

Feral Cat	Felis catus	Male	E9a	-26.30306	121.45068	Ground	Cat scat and urine	27/10/2015	Shot in trap
Feral Cat	Felis catus	Male	E10a	-26.30305	121.45603	Ground	Tweeter	27/10/2015	Shot in trap
Feral Cat	Felis catus	Male	E7a	-26.30308	121.43984	Ground	Cat scat	3/11/2015	Shot in trap
Goanna	Varanus sp	Unknown	E?			Ground	Unknown	5/11/2015	Died in trap
Feral Cat	Felis catus	Female	NW4	-26.29031	121.38583	Drum	Cat scat	13/11/2015	Shot in trap
Feral Cat	Felis catus	Male	NN06	-26.28692	121.37666	Drum	Cat scat	16/03/2016	Shot in trap