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Warralong Feral Cat Monitoring 2023

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Warralong Feral Cat Monitoring

2023

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GOVERNMENT OF WESTERN AUSTRALIA

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Cover image: Feral cat on Coongan Station (credit Roy Hill)

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1 Introduction

In 2014, the Department of Biodiversity, Conservation and Attractions (DBCA) collaborated with members of the Warralong community to identify an active bilby population on the Coongan Pastoral Lease. In subsequent years, bilby presence was observed in 2015, 2016, 2018, 2019, 2021 and 2022 (Dziminski *et al.* 2020; Dziminski *et al.* 2020; Dziminski *et al.* 2021; Moore 2022a).

A collaborative project was launched in 2018 to monitor and manage threats to the bilby population at Warralong, involving the Warralong Community, DBCA, Roy Hill (RH), and Greening Australia (GA). In 2019, RH commenced funding Greater Bilby Offset Project 1, which was approved by the Commonwealth Government.

This Offset Project, covers part of the Coongan Pastoral Lease with management activities identified including patch burning, introduced predator control, and introduced herbivore management. Management activities are to be focused on a defined area, the Bilby Land Management Area (BLMA), within which bilbies are known to occur.

In June 2022, the first round of introduced predator management was delivered, involving the aerial deployment of ~5,750 Eradicat® baits within the BLMA. A second aerial deployment of ~5,750 Eradicat® baits was conducted in July 2023. To evaluate the effectiveness of this baiting, a before and after control and impact (BACI) monitoring design was implemented to detect changes in feral cat occupancy and activity pre and post baiting. This report summarises findings from the analysis of the 2023 monitoring data.

Specific objectives of the analysis were to:

1. Measure the effect of Eradicat® baiting on feral cat occupancy within the BLMA.
2. Measure the effect of Eradicat® baiting on feral cat activity within the BLMA.
3. Measure the effect of Eradicat® baiting on feral cat prey species within the BLMA, including small mammal and reptiles.
4. Provide directions for future feral cat monitoring within the BLMA based on the above.

2 Methods

2.1 Eradicat® baiting

Eradicat® is a toxic bait designed to target feral cats (Algar and Burrows 2004). It contains a lethal dose of the active ingredient, 1080, and has been shown to be effective in reducing feral cat populations (Algar *et al.* 2013; Comer *et al.* 2018; Fancourt *et al.* 2022). Eradicat® baits were successfully deployed across the BLMA at a density of 50 baits per 1 km^2 on the 28th July 2023. Helicopter Logistics Pty Ltd were responsible for bait delivery, with bait preparation undertaken by licenced personnel from the DBCA Exmouth office.

2.2 Data collection

2.2.1 Camera traps

Camera trap monitoring was conducted at 30 sites spread across the study area using Reconyx PC900 Hyperfire Professional cameras. A total of 20 cameras were positioned inside or bordering the BLMA, and 10 cameras outside the BLMA (Figure 1). Camera trap effort was designed to maximise our capacity to measures changes in feral cat occupancy within the BLMA, where Eradicat® baits were deployed.

Camera traps were deployed between 8/02/2023 to 14/11/2023, totalling 279 days. This provided approximately 140 days (20 weeks) of camera trap data either side of Eradicat® deployment, which is sufficient to achieve a reasonable level of statistical power to detect changes in feral cat occupancy (Guillera-Arroita and Lahoz-Monfort 2012; Moore 2022b).

Cameras were mounted on 90 cm aluminium fence droppers (Figure 2), and positioned next to tracks to maximise feral cat detectability and statistical power (Moore 2022b).

Animals in camera trap images were identified by trained observers.

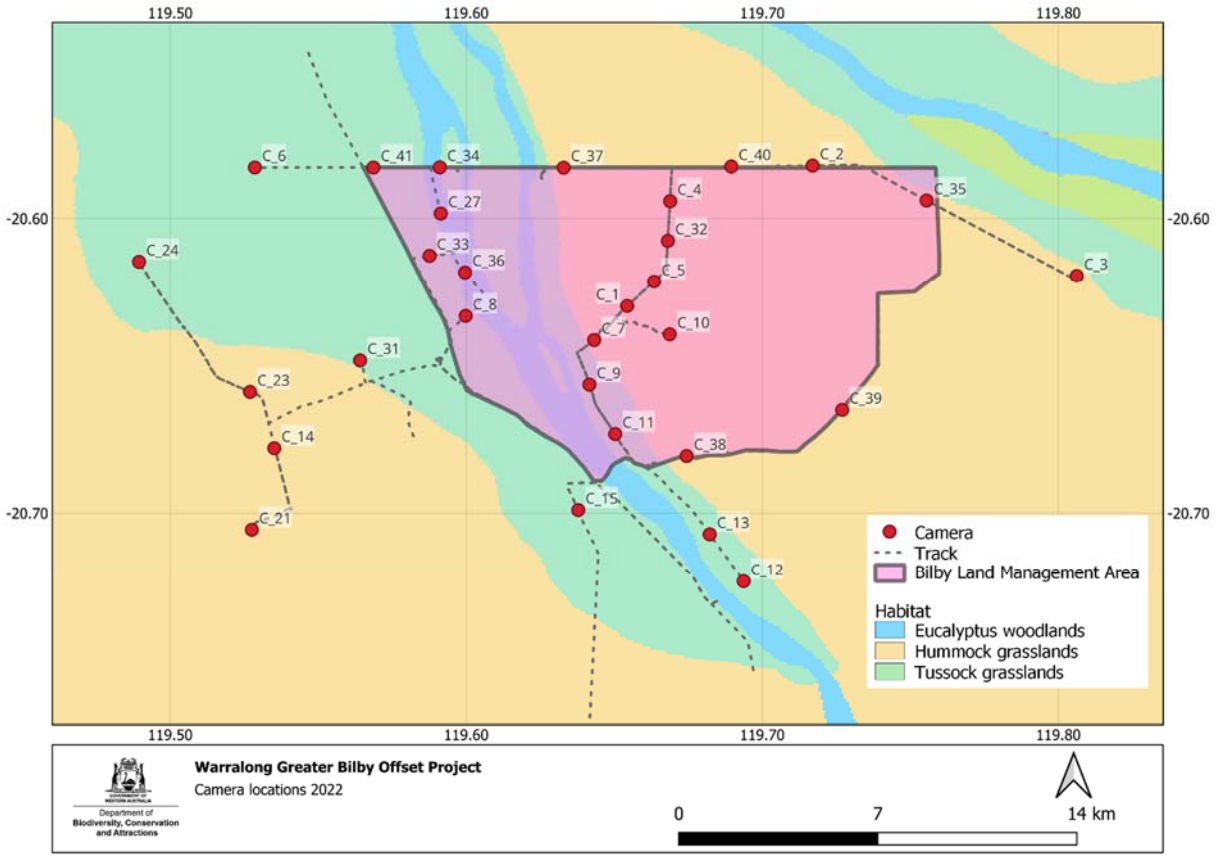

Figure 1. Camera trap locations inside and outside the Bilby Land Management Area, with Eradicat® baits aerially deployed within the BLMA in 2023.

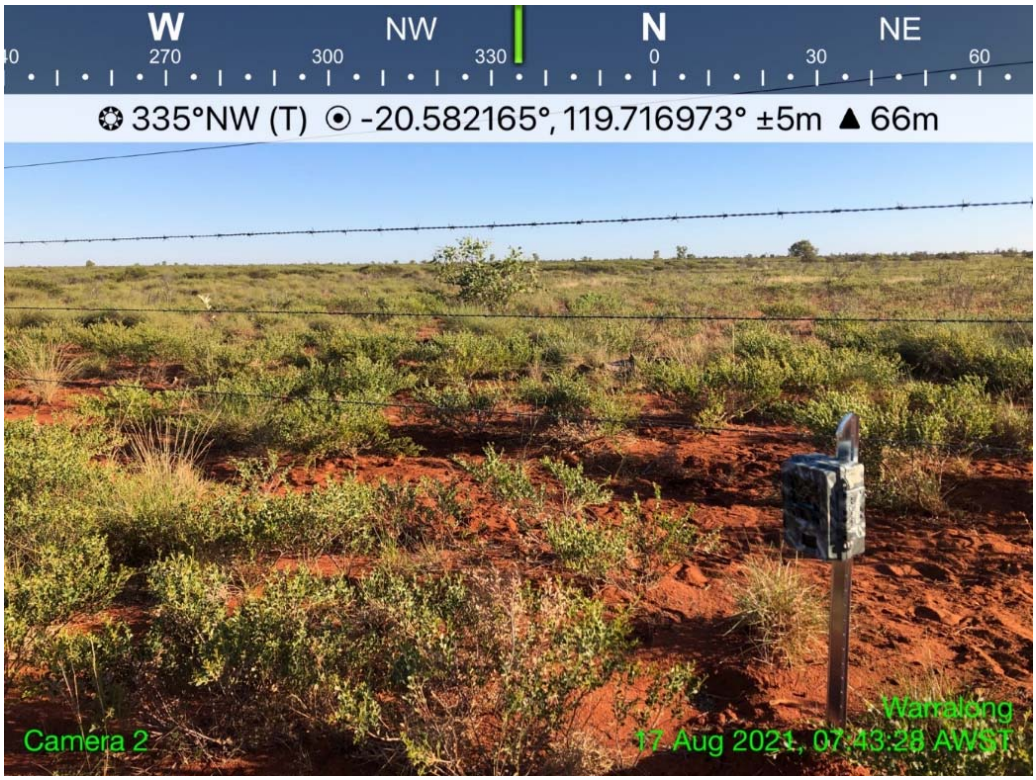

Figure 2. Typical camera trap set up used to detect feral cats as part of the Warralong Greater Bilby Offset Project.

2.2.2 2-ha plot surveys

A total of 31 x 2-ha plots were surveyed across the study area (Figure 3). The standardised 2-ha sign plot technique provides systematically quantified and comparable data and is currently applied broadly in parts of arid and semi-arid Australia (Southwell *et al.* 2022). At each 2-ha plot, trained observers recorded animal sign as well as plot covariates in a 2-ha area and along 100 m of nearby vehicle track. During this survey, data was collected electronically using Mobile Data Studio.

Each 2-ha plot was surveyed seven times in 2023 (March, May, June, August, September, October, November) (Table S1). March data was not received and is not included in this analysis (this is unlikely to change the results given that there are two other surveys prior to baiting). This provided two surveys prior to the deployment of Eradicat® baits (conducted on 28 July 2023), and four surveys following the deployment of baits.

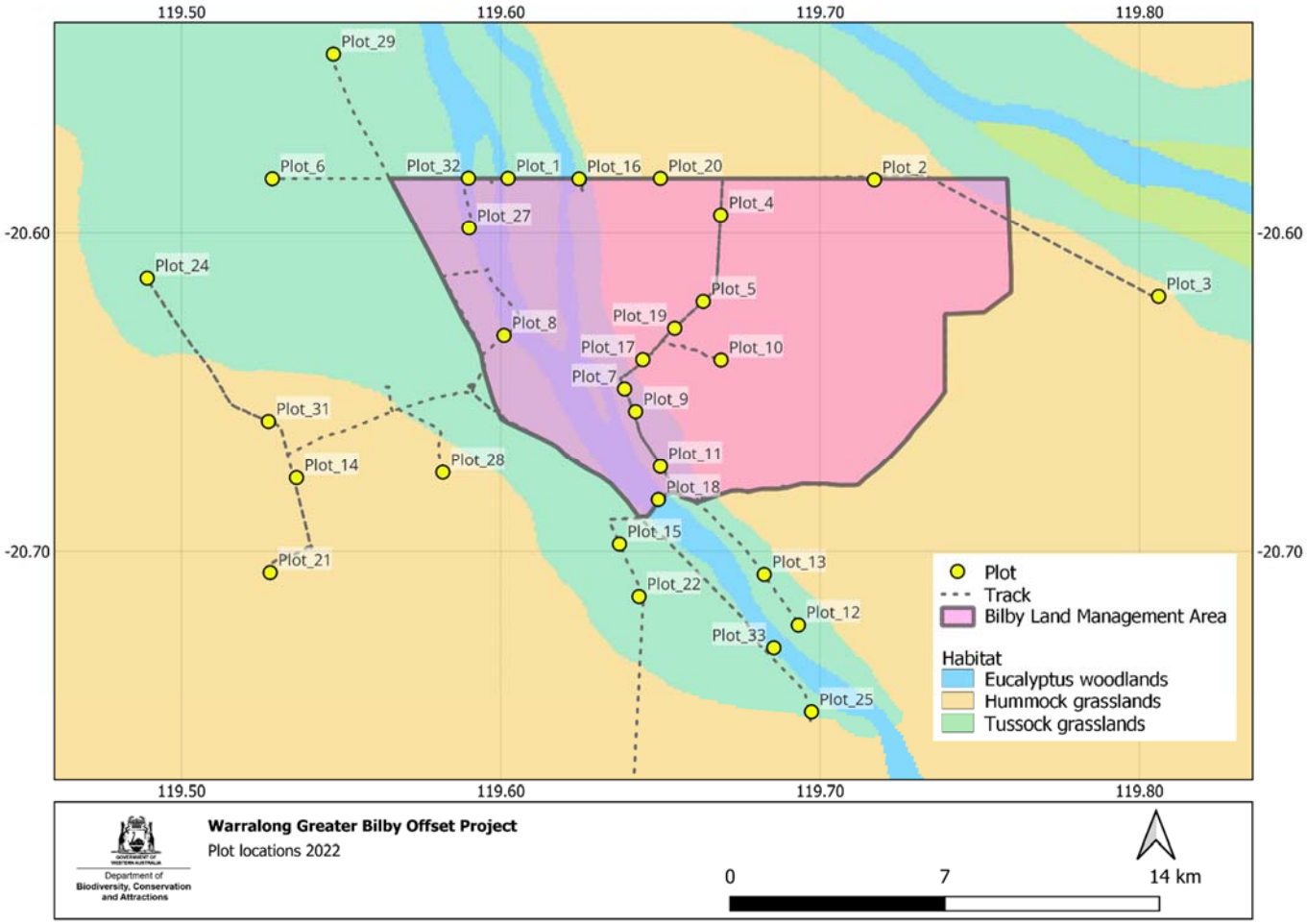

Figure 3. Plot survey locations inside and outside the Bilby Land Management Area, within which Eradicat® baits were deployed in 2023.

2.2.3 Occupancy analysis

We used dynamic occupancy models to detect changes in feral cat occupancy in response to Eradicat® baiting. Models were fitted using the package *Unmarked* (Fiske and Chandler 2011) in the R statistical software (R Core Team 2021). Dynamic occupancy models use data from primary periods (pre-baiting and post-baiting), each comprising a series of secondary periods. In this analysis, secondary periods were made up of 14-day blocks of camera trap data, or individual 2-ha plot surveys (following Moore (2022b)). These models do not rely on the assumption of a closed system between primary periods, and allow users to estimate initial site occupancy rates, as well as colonisation and extinction probabilities, which account for changes in site occupancy between primary periods, i.e., pre- and post-baiting periods. This approach has previously been used to examine the effect of Eradicat® baiting (Doherty *et al.* 2021).

To determine if the application of Eradicat® reduced feral cat occupancy, we fitted a suite of models with treatment (baited or unbaited) as a predictor for initial occupancy, as well as extinction and colonisation probability. Models were then ranked based on AICc. Evidence for the efficacy of baiting was established if the treatment demonstrates a significant effect on the probability of extinction ($p < 0.05$). Models were fitted separately for camera trap and plot data.

Occupancy predictions were generated by drawing samples from empirical Bayes posterior predictive distribution derived from unmarked models. This is a statistical technique that uses observed data to estimate the distribution of future observations and provides a more accurate prediction of future outcomes.

To test if baiting had any effect on feral cat prey species, we repeated the above analysis for small mammals (rodents, dasyurids) and small to medium sized reptiles (skinks, goannas, small snakes) using 2-ha plot data.

2.2.4 Activity analysis

We used generalised linear models fit with Gaussian distribution to assess changes in cat activity in response to baiting. Models were fit using the package *lme4* (Bates *et al.* 2015) in the R statistical software (R Core Team 2021). Feral cat activity was assessed as the number of detections recorded at a site per 100 trap nights, following previous studies (Doherty and Algar 2015; Moseby *et al.* 2020; Palmer *et al.* 2021). Independent detections were defined as those separated from one another by at least 15 minutes. Models included an interaction term between treatment (baited or unbaited) and period (pre-baiting or post-baiting) as a fixed effect. Evidence for the efficacy of baiting was established if there was significant effect ($p<0.05$) of the interaction terms (treatment*period) on cat activity.

3 Results

In 2023, feral cats were detected 86 times on cameras traps, across 24/30 sites, and detections were spread reasonably evenly across the sampling period (Figure 4). Over the same period, feral cats were detected 14 times during 2-ha plot surveys, across 10/31 plots.

Other species commonly detected during camera and plot surveys included dingos (*Canis lupis dingo/ Canis familiaris*), brush-tailed mulgara (*Dasycercus blythi*), spinifex hopping mice (*Notomys alexis*), and sand goannas (*Varanus gouldii*). A single northern quoll (*Dasyurus hallucatus*) was detected once by C41, located on the northern boundary between the baited and unbaited areas. A single red fox (*Vulpes vulpes*) was also detected once on the southern edge of the non-baited area at C21.

Nine cameras were disturbed during the sampling period (C3, C4, C21, C31, C33, C34, C38, C39, C41), reducing the total number of sampling occasions across all cameras from 480 to 429. It is unlikely this reduction in sampling effort had a significant effect on the results.

3.1 Occupancy analysis

Treatment (baited vs unbaited) was not included in top models for feral cats, small mammals or for reptiles, suggesting there was no detectable effect of baiting on occupancy for any of these species' groups (Table 1, Figure 5, Figure 6). There was also no effect of feral cat baiting on dingo occupancy (Figure S1 in Section 7 Supplementary Material).

Results from feral cat occupancy models using camera trap data indicated that feral cat occupancy was slightly less inside the BLMA pre- and post-baiting, but there was no change in occupancy as a result of baiting (Figure 5). The model using feral cat plot data indicated there was no change in feral cat occupancy post baiting either inside or outside the BLMA (Figure 6). Small mammal occupancy increased post baiting in both treatments (Figure 7) and reptile occupancy appears to be slightly higher inside the BLMA regardless of treatment (Figure 8).

3.2 Activity analysis

Feral cat activity remained relatively consistent during the sampling period, with a slight decrease in activity later in the year, after baiting had occurred (Figure 9). This small decrease in activity occurred in both baited and unbaited areas, and results from the generalised linear model indicated that there were no detectable differences in feral cat activity between before and after baiting, or in baited and unbaited areas (Table 2, Figure 10).

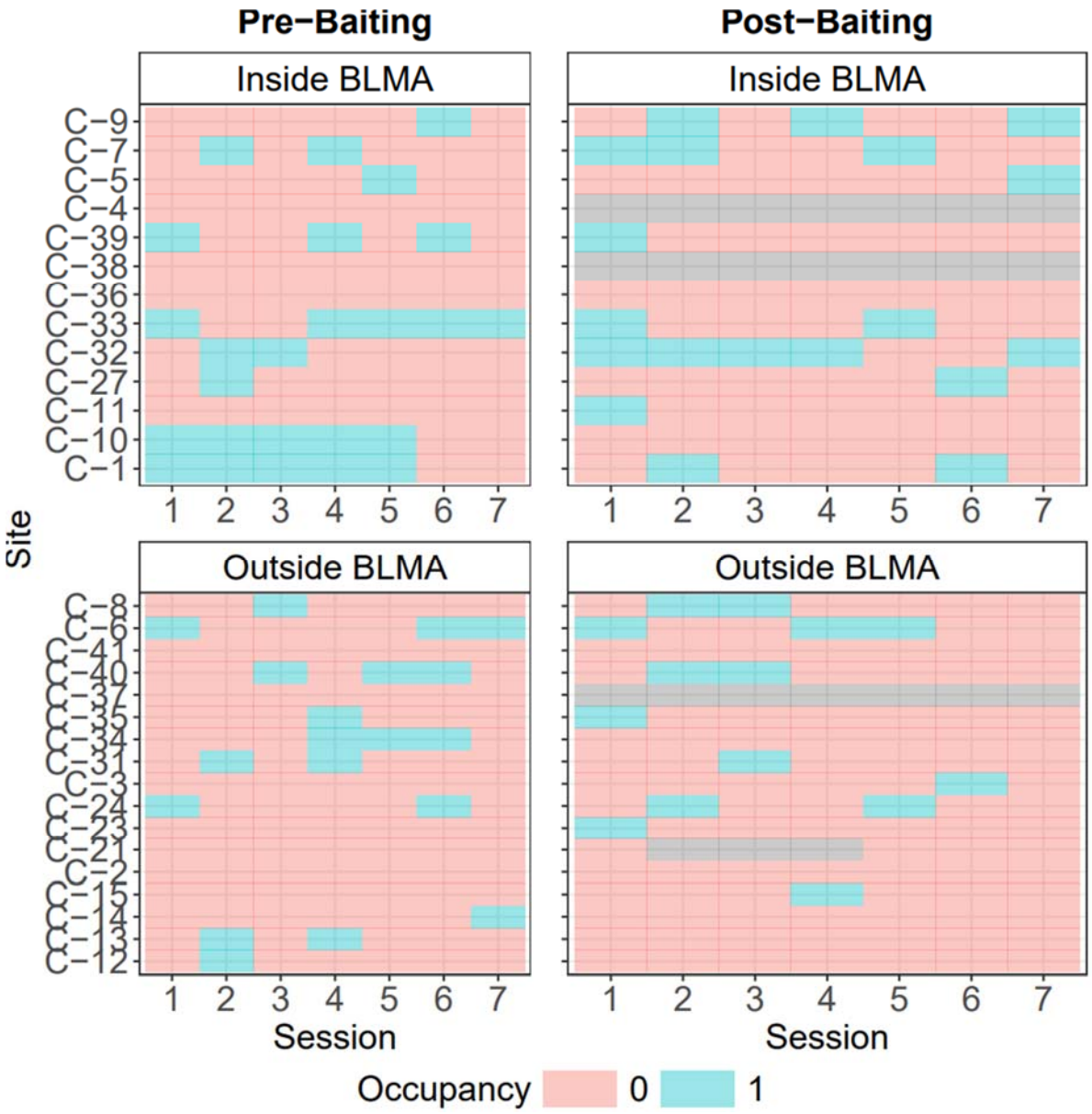

Figure 4. 2023 Raw feral cat occupancy data from camera trap surveys conducted inside and outside the Bilby Land Management Area adjacent to Warralong community, pre and post Eradicat® baiting. Grey blocks indicate camera failures.

Table 1 - Occupancy model selection tables

psi.Int.	col.Int.	ext.Int.	p.Int.	psi.baited	col.baited	ext.baited	df	AICc	delta
Feral cat camera trap occupancy									
0.84	-0.18	-1.47	-1.07				4	441.53	0.00
0.80	-0.15	-3.44	-1.06			+	5	442.64	1.11
0.84	-1.66	-1.47	-1.07		+		5	443.12	1.59
0.84	-1.97	-3.92	-1.07		+	+	6	444.11	2.59
1.06	-0.14	-1.45	-1.06	+			5	444.25	2.72
Feral cat plot occupancy									
0.06	-6.68	-2.62	-1.23				4	94.59	0.00
-0.84	-3.54	-2.33	-1.21	+			5	96.37	1.79
0.15	-4.94	-0.02	-1.23			+	5	96.85	2.26
0.06	-8.08	-2.70	-1.23		+		5	97.45	2.86
Small mammal plot occupancy									
-0.78	2.27	-4.70	-1.60				4	88.74	0.00
-0.95	1.64	6.01	-1.41			+	5	90.57	1.83
-0.82	0.48	-4.70	-1.57		+		5	91.34	2.60
-0.75	2.31	-4.58	-1.60	+			5	91.60	2.86
Reptile plot occupancy									
1.37	-7.99	-9.79	-0.06				4	169.48	0.00
3.41	-5.05	-9.45	-0.06	+			5	170.17	0.69
1.37	-7.25	-8.94	-0.06			+	5	172.34	2.86
1.37	-6.25	-9.80	-0.06		+		5	172.34	2.86

Table 2. Generalised linear model selection table for the effect of baiting (baited or unbaited) and session (before or after bait drop) on cat activity.

Intercept.	baited	Session	baited.Session	df	AICc	delta
0.027				3	-163.1	0
0.037	+			4	-156.4	6.65

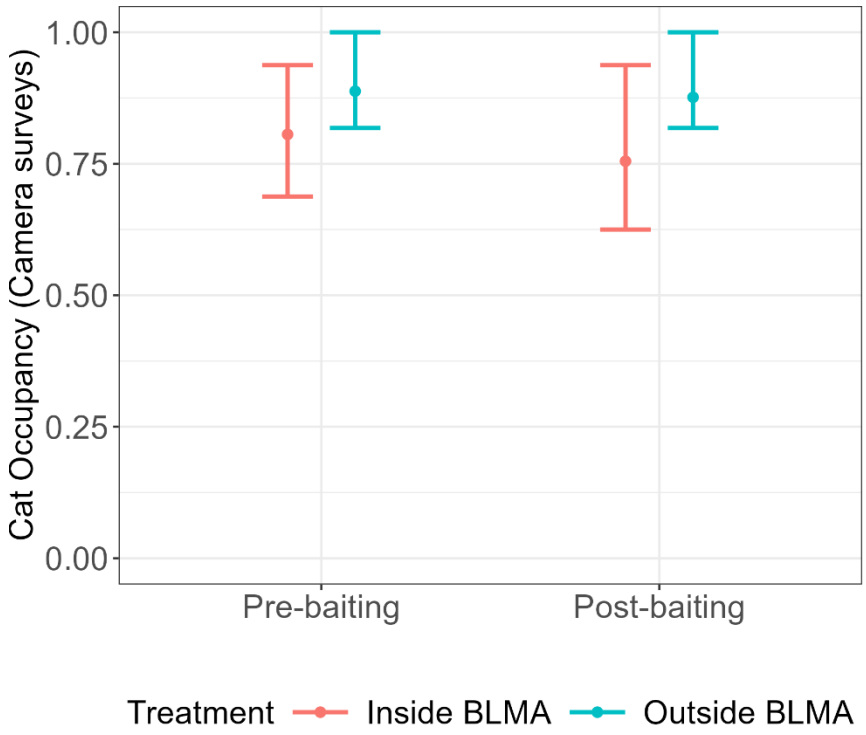

Figure 5. Predicted feral cat occupancy based on camera trap data collected inside and outside the BLMA , pre and post Eradicat® baiting.

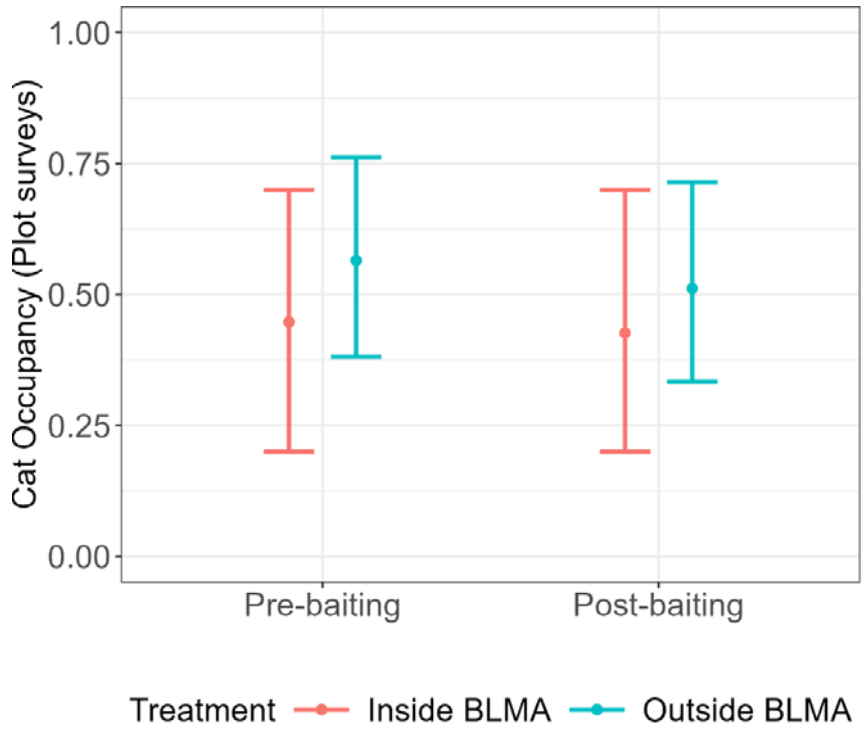

Figure 6. Predicted feral cat occupancy based on plot survey data collected inside and outside the BLMA, pre and post Eradicat® baiting.

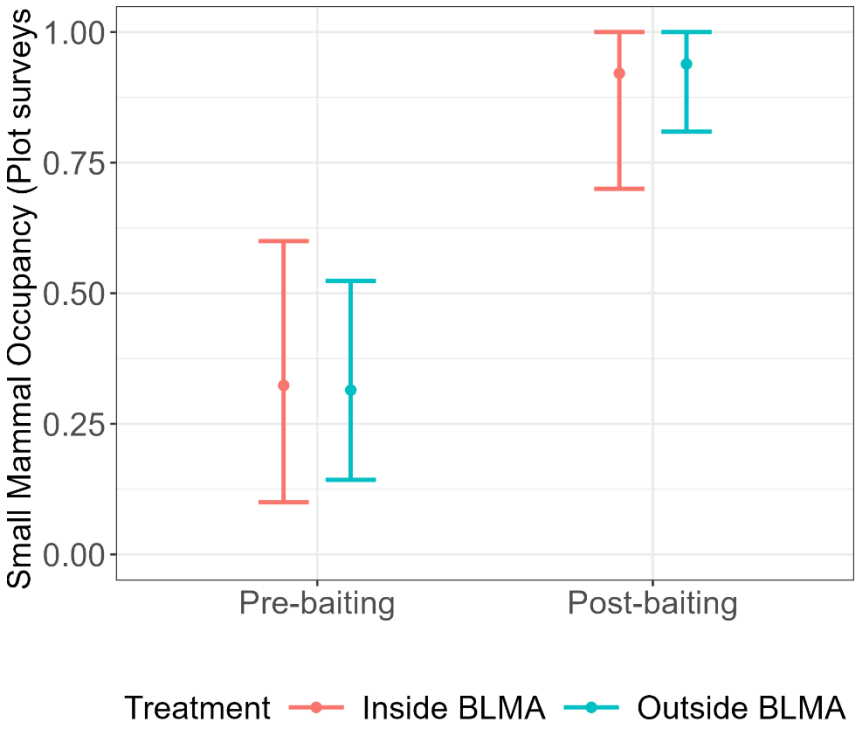

Figure 7. Predicted small mammal occupancy based on plot survey data collected inside and outside the baited area pre and post Eradicat® baiting

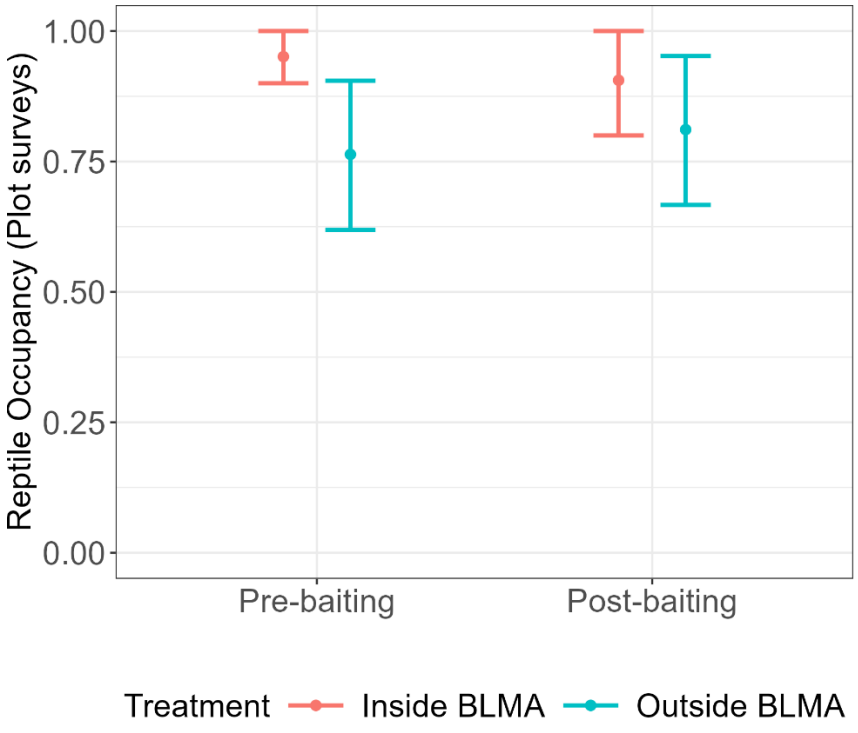

Figure 8. Predicted small-medium sized reptile occupancy based on plot survey data collected inside and outside the baited area, pre and post Eradicat® baiting.

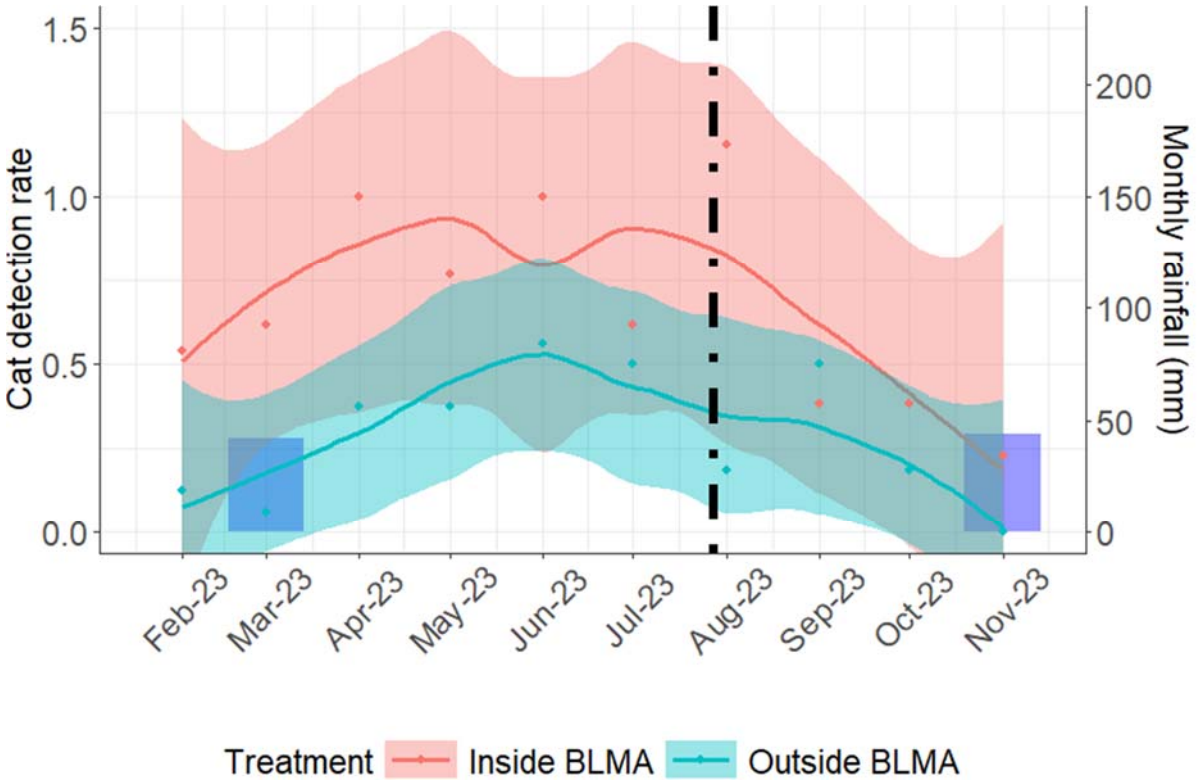

Figure 9. Averaged monthly detection rate for feral cats inside and outside the baited area. Purple columns represent rainfall recorded at closest weather station to Warralong (Carlindie – 004008). Blue and red shading represent 95% confidence intervals from linear model. Dark dashed vertical line indicated time of baiting.

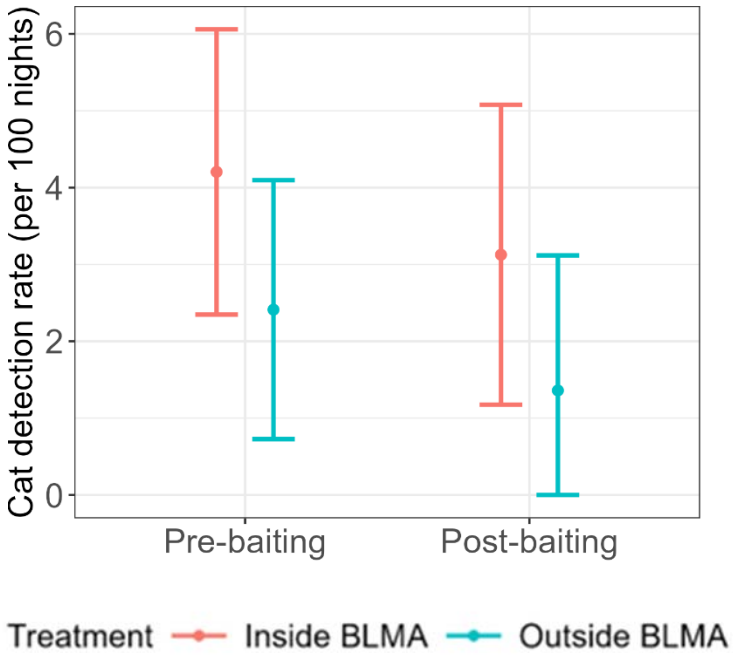

Figure 10. Predicted feral cat detection rate (per 100 trap nights) from generalised linear model using data from camera trap surveys inside and outside the BLMA area, pre and post Eradicat® baiting.

4 Discussion

Results from this analysis suggest Eradicat® baiting did not have a detectable effect on feral cat occupancy (measured using both camera trap and sign plot data), or on the feral cat detection rate. Further, we did not find any significant effect of baiting on feral cat prey species (reptiles and small mammals). This is the second consecutive year that baiting was found to have no detectable effect on fauna occupancy in the BLMA.

The efficacy of Eradicat® baiting to reducing feral cat occupancy/abundance in arid and semi-arid Australia has yielded mixed results. While some recent studies have reported positive outcomes (Comer *et al.* 2018; Lohr and Algar 2020; Algar *et al.* 2020; Moseby *et al.* 2021; Fancourt *et al.* 2022), including in the Pilbara (Comer *et al.* 2018), others have found no effect (Wysong *et al.* 2020; Doherty *et al.* 2021; Palmer *et al.* 2021) or inconsistent effects (Comer *et al.* 2020). The effectiveness of Eradicat® baiting can be largely driven by deployment design and environmental conditions. There are a number of potential explanations for why we did not observe an effect of baiting on feral cat occupancy or activity in this analysis.

The success of a baiting program depends predominantly on the uptake of Eradicat® baits by cats. This can be compromised if cats do not encounter baits, or if they choose not to eat the baits. The effective baiting density could have been reduced in the BLMA if bait uptake by non-target species (such as varanids) was high. Previous research has shown that non-target uptake of baits can be high. For example, 22% of feral cat baits were removed by non-target species at Peron Peninsula (Algar *et al.* 2007), 14–57% at Arid Recovery (Moseby and Hill 2011), 71% at Kangaroo Island (Hohnen *et al.* 2019), 94% at Dryandra (Friend *et al.* 2020), and 90% at Charles Darwin Reserve (Doherty *et al.* 2021). Although the density of non-target species in some of these aforementioned areas may be higher than that at Warralong, reptile occupancy was close to 100% in the Warralong baited area (Figure 8), which suggests that non-target uptake of baits by varanids could be high in this case.

Studies have shown that cat personality can play an important role in baiting efficacy, where shy cats may be unlikely to take a bait, regardless of environmental conditions (Algar *et al.* 2011). Moreover, bait aversion can occur if cats consume a sub-lethal dose of 1080 (e.g., a bait that has decomposed in the landscape) (Fancourt *et al.* 2021; Palmer *et al.* 2021). When such individuals exist in a population, baiting alone is unlikely to be effective. Conducting baiting in conjunction with other cat control methods, such as shooting, trapping, or Felixer feral cat grooming traps™ could help to reduce cat occupancy in this case (Lohr and Algar 2020).

High reinvasion rates by feral cats may comprise the success of baiting, and similar findings have been observed elsewhere (Algar *et al.* 2013). For example, after 4 years of annual aerial baiting in the Fortescue Marsh (~86,900 ha), there was a 30% mortality of radio-collared cats, but no change in feral cat capture rates, suggesting

that the baiting program had a limited effect in reducing the overall cat population (Clausen *et al.* 2015). However, if reinvasion had obscured the overall impact of baiting in our study area, a reduction in feral cat activity would still have been anticipated immediately following bait deployment, which was not observed (Fig. 10). While there appears to be a mild decrease in cat activity following baiting (Fig. 9), this is observed in both the baited and unbaited sites and is more likely to represent seasonal fluctuations in cat activity, than a response to baiting.

The relatively small size of this baited area (~11,500 ha) may have impacted baiting efficacy. Feral cat home-ranges are thought to range between 500 and 3,400 ha in the Pilbara (Williamson *et al.* 2021), and it is possible that the baited area only overlaps with a small number of cats, limiting its efficacy (especially if any of these cats are bait averse).

Finally, power analysis by Moore (2022b) indicates that the existing camera trap monitoring array can detect a 30% or greater change in feral cat occupancy with a moderate to high level of confidence (approximately 70%) within the BLMA. It is possible that we did not have sufficient power in our data to detect an effect of baiting if the change in occupancy was <30%.

5 Future directions

- Baits should be deployed when the likelihood of uptake by feral cats is highest – typically following a period of low rainfall, and in the cooler months, when prey availability is low (Algar *et al.* 2007). While this approach requires some flexibility in terms of scheduling and may pose logistical challenges (i.e., allowing for delays in bait drops in response to unseasonal rainfall events), it is likely to substantially increase bait uptake by cats, and ultimately improve the impact of the management program in reducing feral cat populations and their impact on prey species, including the bilby. A bait uptake experimental trial may help to elucidate any issues with non-target species.

- Implementing targeted feral cat control measures in conjunction with broad scale baiting has been demonstrated to be effective at further reducing feral cat occupancy (Comer *et al.* 2020; Lohr and Algar 2020; Algar *et al.* 2020). Implementing targeted control methods (e.g. trapping, shooting, Felixer feral cat grooming traps™) in priority locations (bilby activity areas) may increase the efficiency and effectiveness of the feral cat control program at Warralong. Involving local stakeholders such the Warralong community and Yarrie Station in these targeted efforts would encourage local buy-in.

- Increasing the size of the baiting cell may see an improvement in the effectiveness of the baiting program. Incorporating the current location of both bilby colonies inside the baited may help them benefit from any positive effects of baiting.

- Habitat improvement through methods such as strategic burning, can be an effective way to reduce the impact of feral cats on native prey species (Doherty *et al.* 2022). Fire management activities have been proposed for Warralong (Burrows *et al. 2019*) with a perimeter burn implemented in 2020. Small patch burns are conducted by the pastoral station sub-lessee via an aerial program. Cat activity can increase in recently burned areas (Moore *et al.* 2024), and burning should be coupled with ongoing cat control.

- To evaluate the effectiveness of the management program, it is important to continue regular monitoring of feral cat occupancy, activity, and prey populations. This can help to identify trends and adjust the management program as needed to achieve the desired outcomes. The level of confidence in detecting a change in occupancy can be increased by installing more camera trap sites within the BLMA, provided they are located on tracks, and separated from existing cameras by at least 2km, such that they can be classed as independent. Continuation of plot surveys is also recommended, as they offer an alternative method for monitoring feral cat occupancy and are essential for detecting changes in bilby populations, along with other prey species (reptiles, small mammals).

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7 Supplementary material

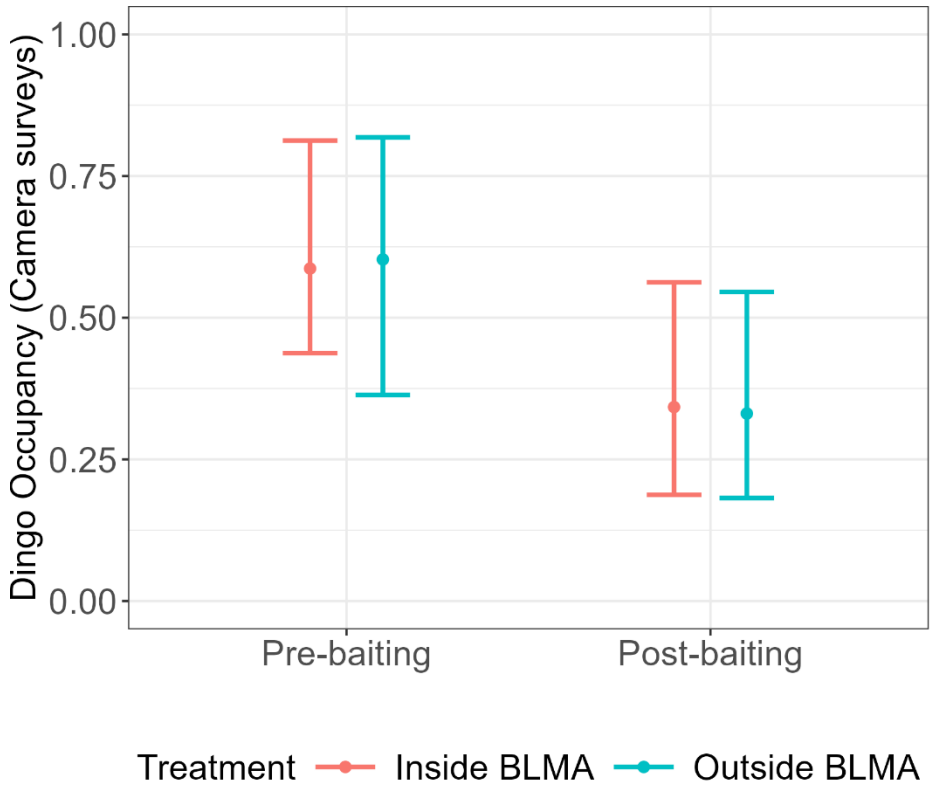

Figure S1 – Predicted dingo occupancy based on camera trap data collected inside and outside the BLMA , pre and post Eradicat® baiting. Occupancy decreases overtime in both treatments, there is no effect of baiting on occupancy.

Table S2 – 2023 plot surveys

#Survey	Dates
1	07/03/2023 – 10/03/2023*
2	03/05/2023 – 04/05/2023
3	07/06/2023 – 09/06/2023
4	16/08/2023 – 17/08/2023
5	13/09/2023 – 15/09/2023
6	11/10/2023 – 12/10/2023
7	08/11/2023 – 10/11/2023

* Data not included in this analysis.