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Warralong Feral Cat Monitoring 2022

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Warralong Feral Cat Monitoring
2022

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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 Background

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, and 2021 (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 contracted GA and DBCA to manage Stage 1 of the Greater Bilby Offset Project 1, which was approved by the Commonwealth Government. This Offset Project, covers 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 ~5750 Eradicat® baits within the BLMA. 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 this 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 recommendations for future feral cat monitoring within the BLMA based on the above.

2 Methods

2.1 Eradicat baiting

Eradicat® is a toxic bait used for controlling feral cats in Australia (Algar and Burrows 2004). It contains a lethal dose of the active ingredient, 1080, which causes rapid death in cats. The bait is designed to be highly attractive to cats 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 16^{th} of June, 2022. DBCA's Western Shield program were responsible for bait delivery.

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 2/02/2022 to 1/12/2022, totalling 303 days. This provided approximately 150 days (21 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.

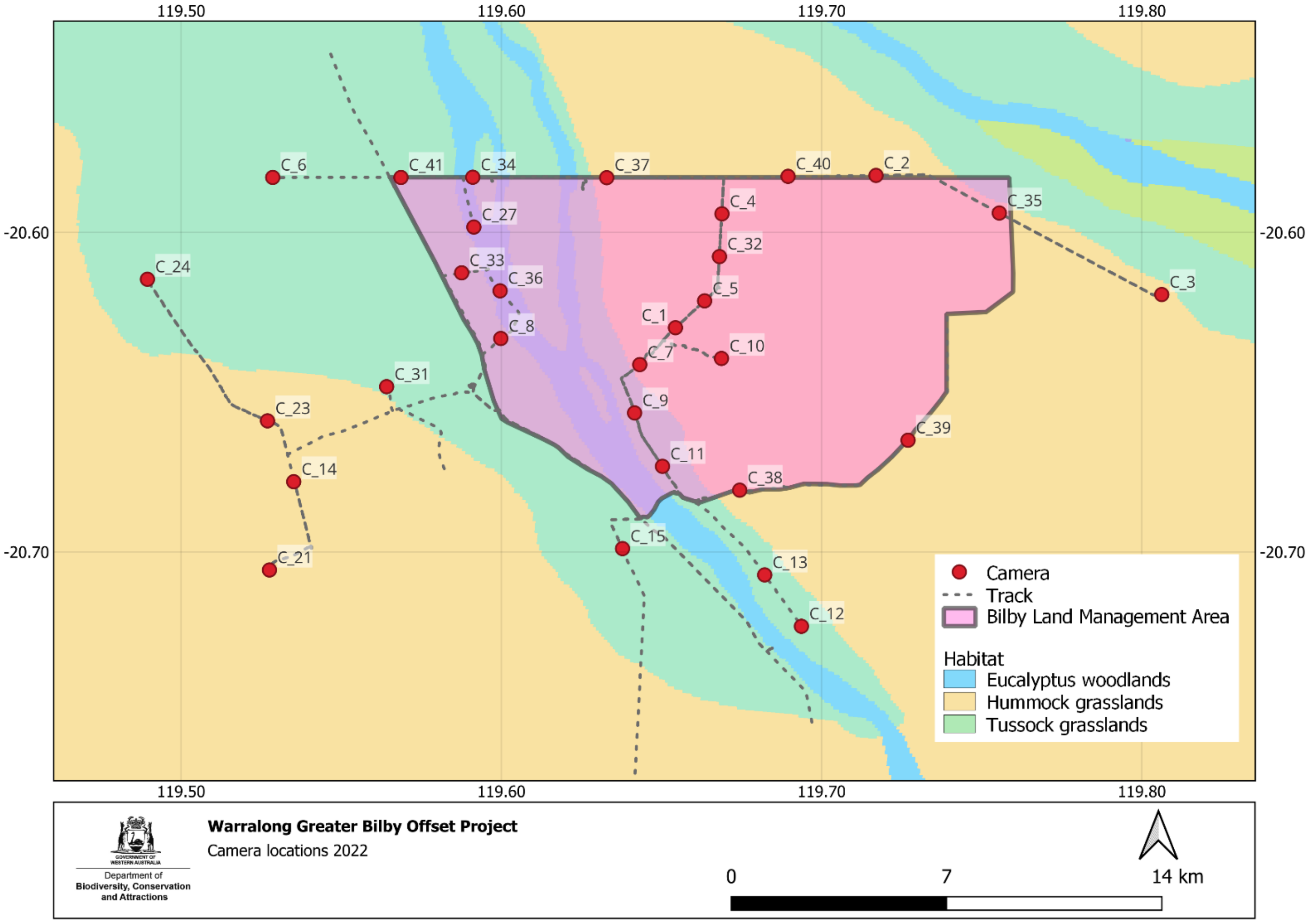

Figure 1 – Camera trap locations inside and outside the Bilby Land Management Area, with Eradicat baits aerially deployed within the BLMA in 2022.

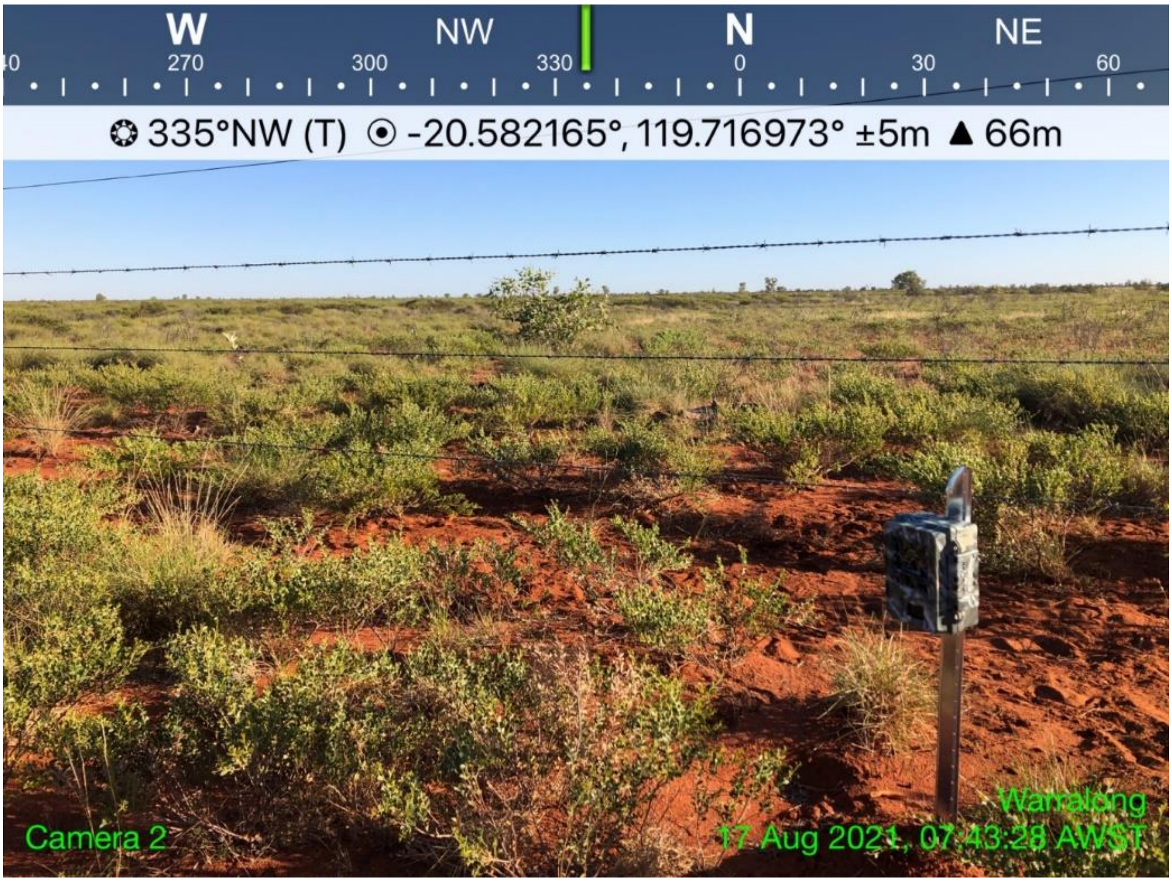

Figure 2 – Typical camera trap set up used to detect feral cats as part of the Warralong Greater Bilby Offset Project.

2.2.2 2-ha plot surveys

A total of 30 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 6 times in 2022 (February, April, July, September, October, November) (Table S1). This provided two surveys prior to the deployment of Eradicat baits, and four surveys following the deployment of baits. A further two pre-baiting surveys were scheduled, however these could not be completed due to restricted access to sites following heavy rainfall.

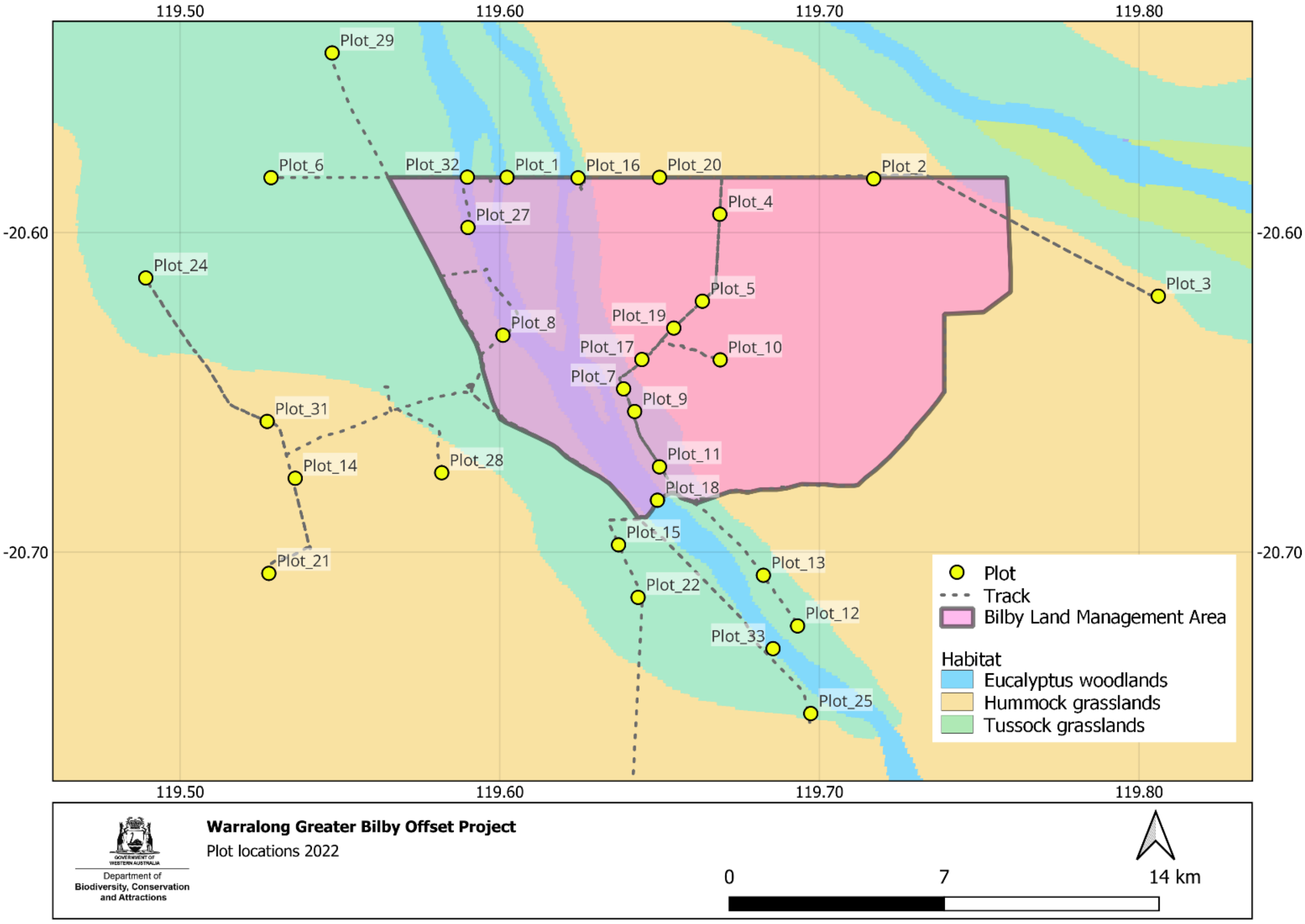

Figure 1 – Plot survey locations inside and outside the Bilby Land Management Area, within which Eradicat baits were deployed in 2022.

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 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 than 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 2022, feral cats were detected 132 times on cameras traps, across 23/30 sites, and detections were spread reasonably evenly across the sampling period (Figure 4). Over the same period, feral cats were detected 32 times during 2-ha plot surveys, across 17/30 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*).

Four camera were disturbed during the sampling period (C34, C41, C31, C39), reducing the total number of sampling occasions across all cameras from 540 to 532. It is unlikely this reduction in sampling effort had a significant effect of 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 there was a slight increase in feral cat occupancy within the baited area post baiting, while feral cat occupancy outside the baited area remained the same (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). Similarly, small mammal (Figure 7) and reptile occupancy (Figure 8) was lower both within and outside the BLMA following baiting, however there was no difference between the two treatments.

3.2 Activity analysis

While there appeared to be some fluctuation in feral cat activity during the 2021 sampling period, activity in 2022 was more consistent, with little change observed following baiting (Figure 9). This was reflected in results from the generalised linear model, which indicated baiting did not have a detectable effect on feral cat activity (Table 2, Figure 10).

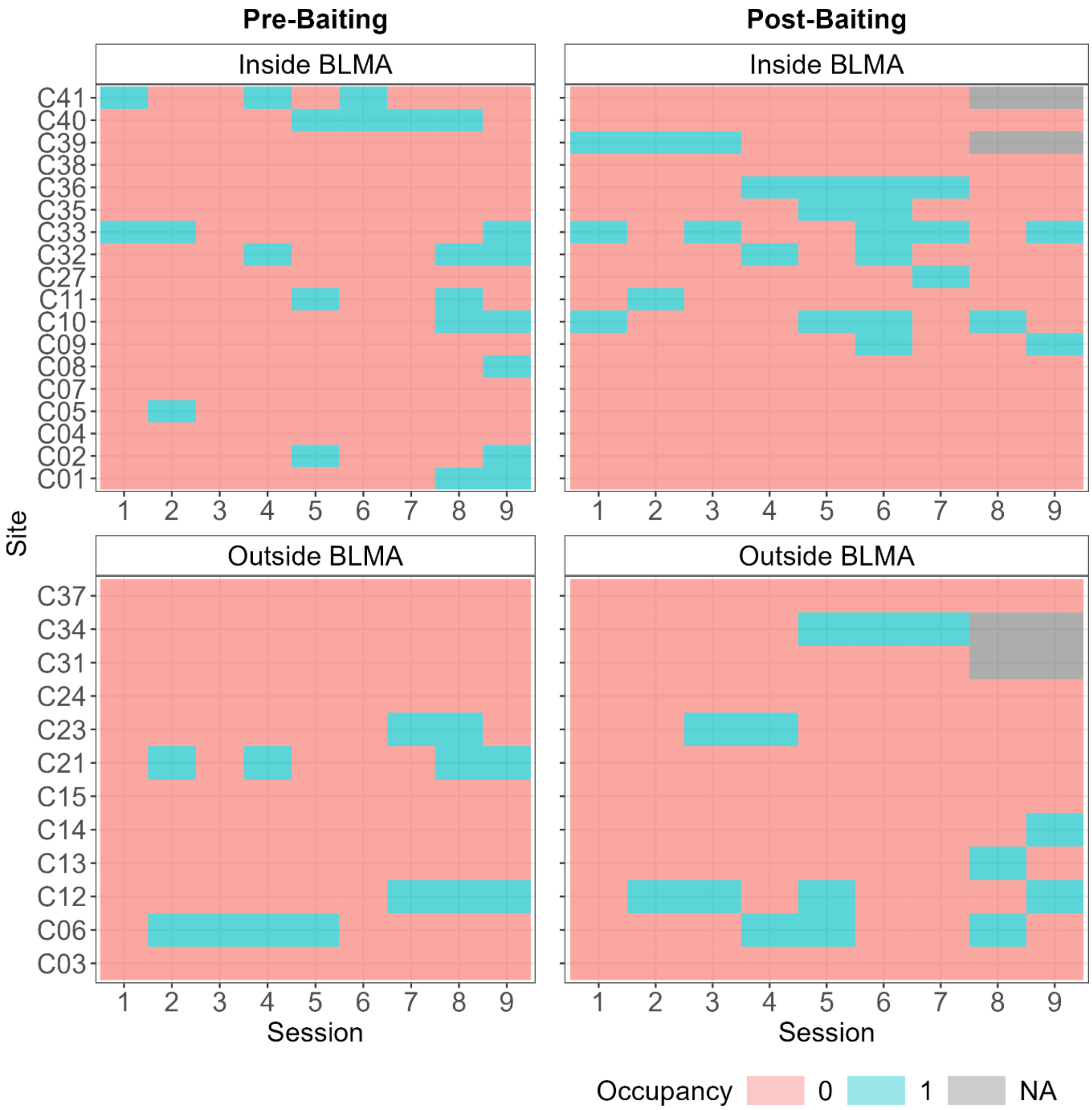

Figure 4 – 2022 Raw feral cat occupancy data from camera trap surveys conducted inside and outside the Bilby Land Management Area adjacent to Warralong community, pre and post Eradicat baiting. NA's indicate camera failures.

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	0.12	-0.46	-1.05				4	407.72	0
0.4	0.11	-0.48	-1.05	+			5	409.14	1.42
0	0.73	-0.46	-1.05		+		5	409.61	1.89
-0.01	0.11	-0.17	-1.05			+	5	409.98	2.26
Feral cat plot occupancy									
0.33	-6.43	-0.16	-0.62				4	175.91	0
0.35	-7.46	1.08	-0.63			+	5	177.33	1.43
-0.08	-7.82	-0.16	-0.62	+			5	178.23	2.32
0.21	-7.52	-0.02	-0.55		+		5	178.4	2.49
Small mammal plot occupancy									
0.51	-8.32	-0.18	-0.86				4	119.16	0
6.29	-8.87	1.45	-0.79	+		+	6	119.45	0.3
2.65	-8.25	-0.18	-0.86	+			5	119.59	0.43
0.28	-8.35	1.09	-0.74			+	5	120.46	1.31
0.51	-7.38	-0.18	-0.86		+		5	121.89	2.73
Reptile plot occupancy									
2.53	-6.04	-1.26	0.53				4	280.53	0
8.02	-2.5	-1.27	0.55	+			5	281.38	0.84
2.52	-6.12	-1.03	0.53			+	5	283.15	2.61

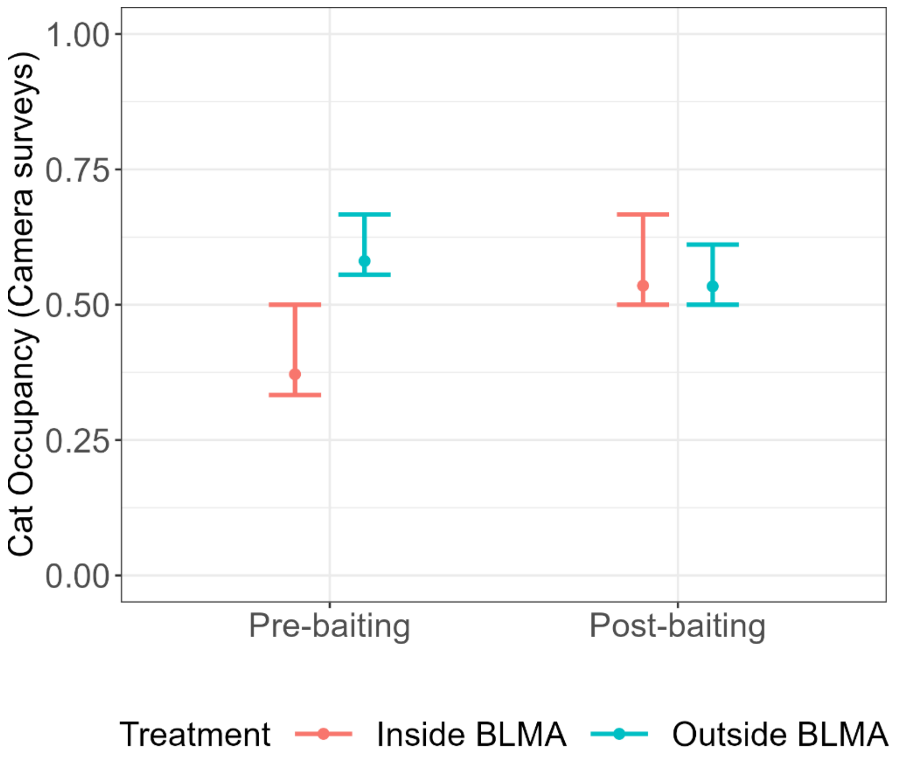

Figure 5 – Predicted feral cat occupancy based on camera trap data collected inside and outside the BLMA , pre and post Eradicat baiting.

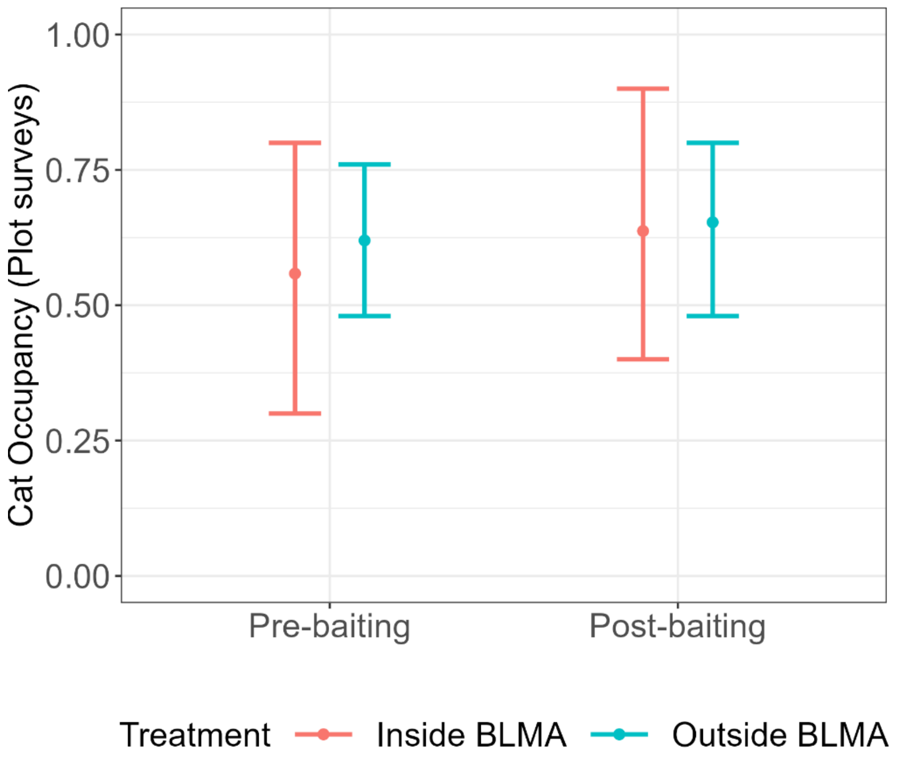

Figure 6 - Predicted feral cat occupancy based on plot survey data collected inside and outside the BLMA, pre and post Eradicat baiting.

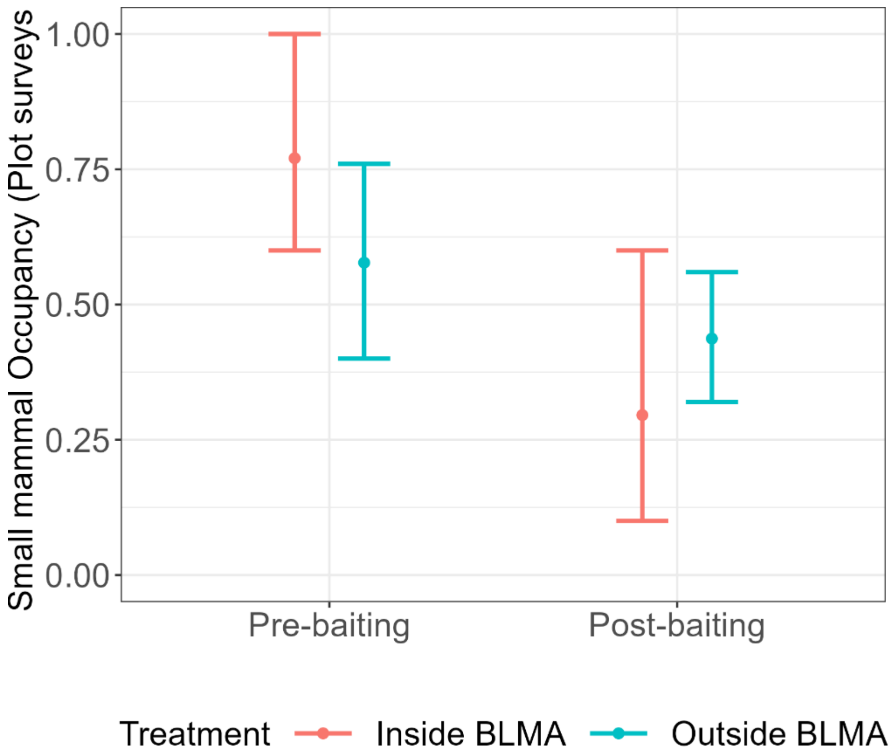

Figure 7 - Predicted small mammal occupancy based on plot survey data collected inside and outside the baited area pre and post Eradicat baiting

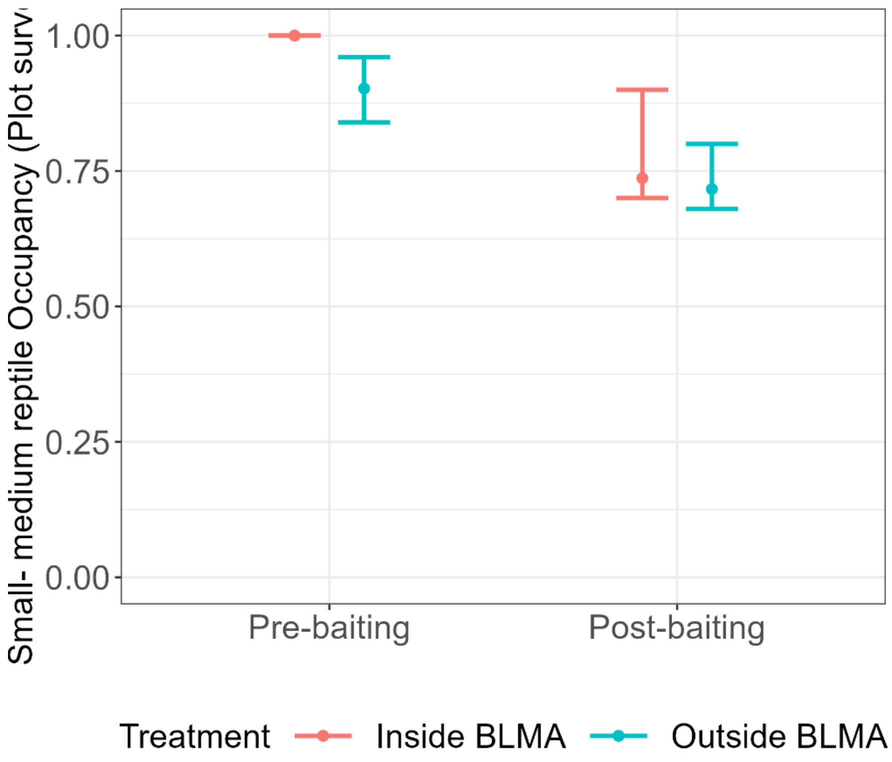

Figure 8 – Predicted small-medium sized reptile occupancy based on plot survey data collected inside and outside the baited area, pre and post Eradicat baiting.

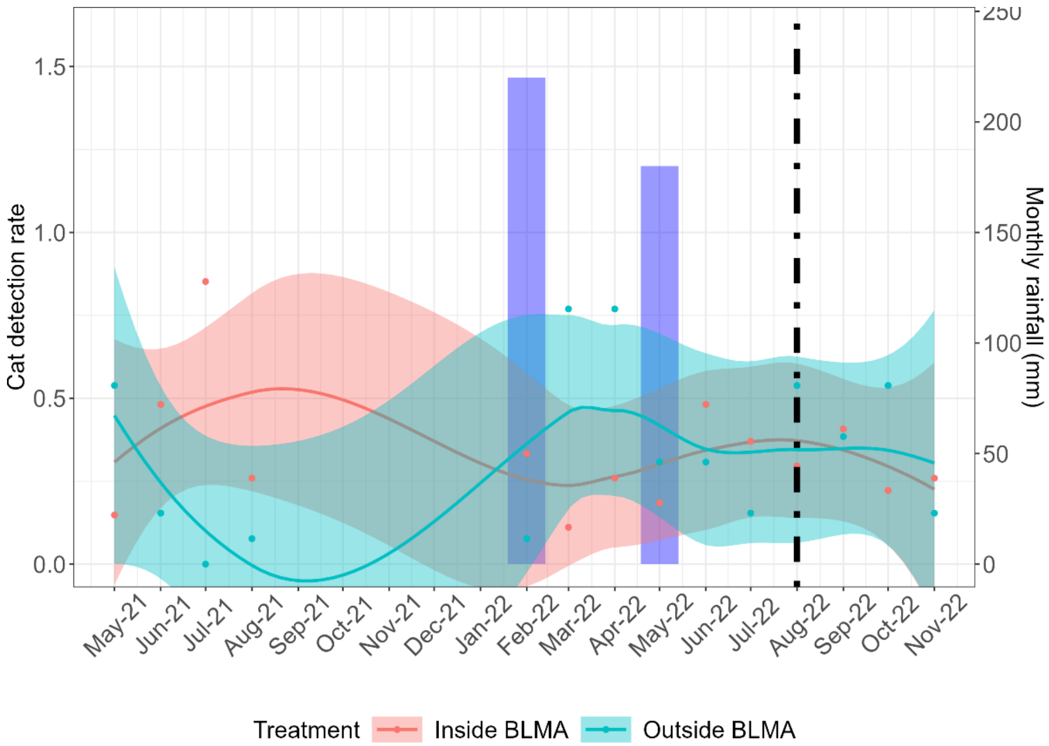

Figure 9 – Averaged monthly detection rate for feral cats inside and outside the baited area. Blue columns represent rainfall recorded at closest weather station to Warralong (Carlindie – 004008). Blue and red shading represent 95% confidence intervals from linear model. Dark dashed vertical line indicated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

Table 2 – Generalised linear model selection table

Intercept.	baited	Session	baited.Session	df	AICc	delta
1.46				2	256.91	0
1.5		+		3	259.11	2.2
1.46	+			3	259.12	2.22

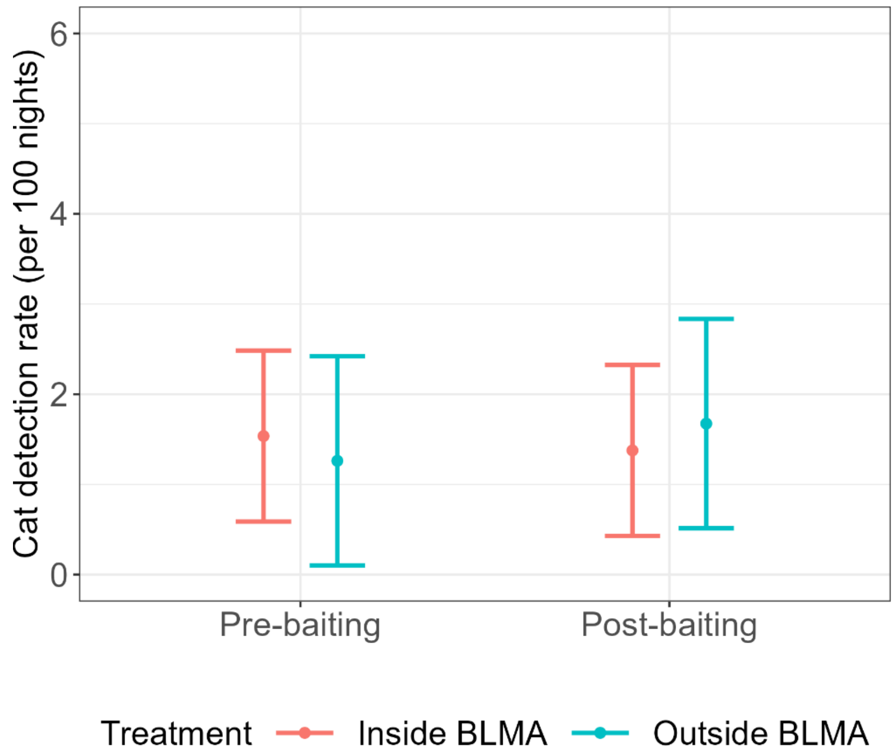

Figure 10 – Predicted feral cat detection rate (per 100 trap nights) from generalised linear model using data from camera trap surveys inside and outside the BLMA area, pre and post Eradicat baiting.

4 Discussion

Results from this analysis suggest Eradicat® baiting did not have a detectable effect on feral cat occupancy (measured using 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 (small reptiles and mammals).

Studies evaluating the effectiveness of Eradicat® in reducing feral cat occupancy/abundance in arid and semi-arid Australia have so far 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).

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.

First, the effective baiting density could have been reduced due to non-target species (Varanids, corvids) consuming the baits, which were demonstrated to be common at sites (Figure 8, also based on visual observations). 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).

In addition to bait removal by non-target species, baiting efficacy can also be influenced by prey availability, which in turn is strongly determined by rainfall in arid and semi-arid regions of Australia (Letnic and Dickman 2010). For example Christensen *et al.* (2013) found reductions in cat activity were greatest when the amount of available prey per cat was lowest. Therefore, it is possible that the high rainfall recorded just before the deployment of baits in April 2022 (Figure 9) may have led to higher prey availability, thereby reducing the effectiveness of the baits.

Finally, the relatively small size of this baited area (~11,500 ha) may have impacted baiting efficacy due to reinvasion of feral cats. Similar effects have been observed elsewhere following Eradicat baiting (Algar *et al.* 2013). However, if reinvasion had obscured the overall impact of baiting, a reduction in feral cat activity would still have been anticipated immediately following bait deployment, which was not observed (Figure).

5 Future directions

- To maximise effectiveness, Eradicat® 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 (i.e allowing for delays in bait drops in response to unseasonal rainfall events, pastoral station activities, access), 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.
- 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. Felixer feral cat grooming traps™) in priority locations (bilby activity areas) is likely to 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 (e.g deploying and monitoring felixer units) would encourage local buy-in.
- 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) . By increasing the availability of shelter and foraging opportunities and a more diverse habitat bilbies are less vulnerable to predation by feral cats. It is therefore suggested that fire management activities proposed within the Warralong fire plan (Burrows *et al*) be implemented so as to reduce the likelihood of large-scale dry season burns and increase vegetation age heterogeneity.
- 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. Power analysis results indicates that the existing camera trap monitoring can detect a 30% or greater change in feral cat occupancy with a moderate to high level of confidence (approximately 70%) within the BLMA (Moore 2022b). This level of confidence 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

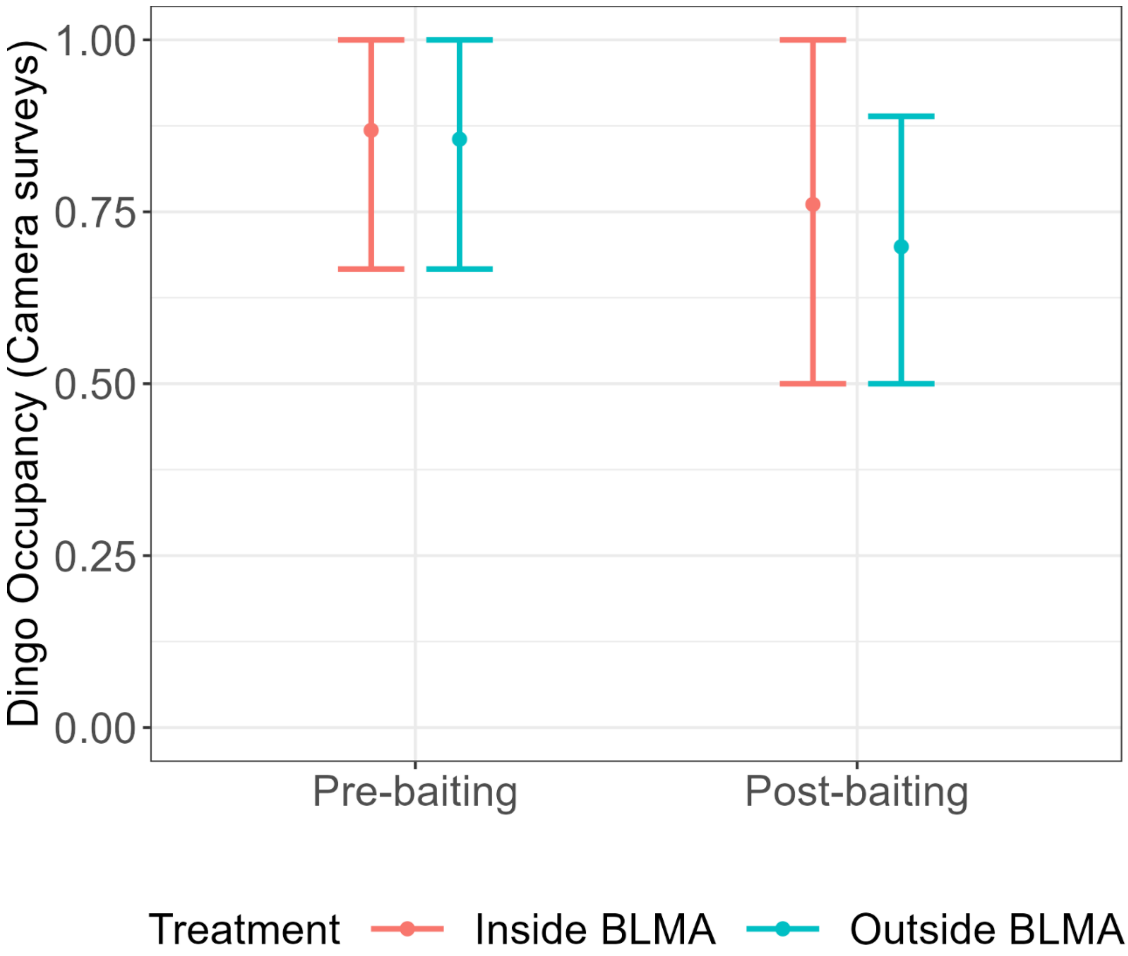

Figure S1 – Predicted dingo occupancy based on camera trap data collected inside and outside the BLMA , pre and post Eradicat baiting.

Table S2 – 2022 plot surveys

#Survey	Dates
1	01/02/2022 – 03/02/2022
2	19/04/2022 – 21/04/2022
3	26/07/2022 – 28/07/2022
4	23/09/2022 – 25/09/2022
5	18/10/2022 – 19/10/2022
6	29/11/2022 – 30/11/2022