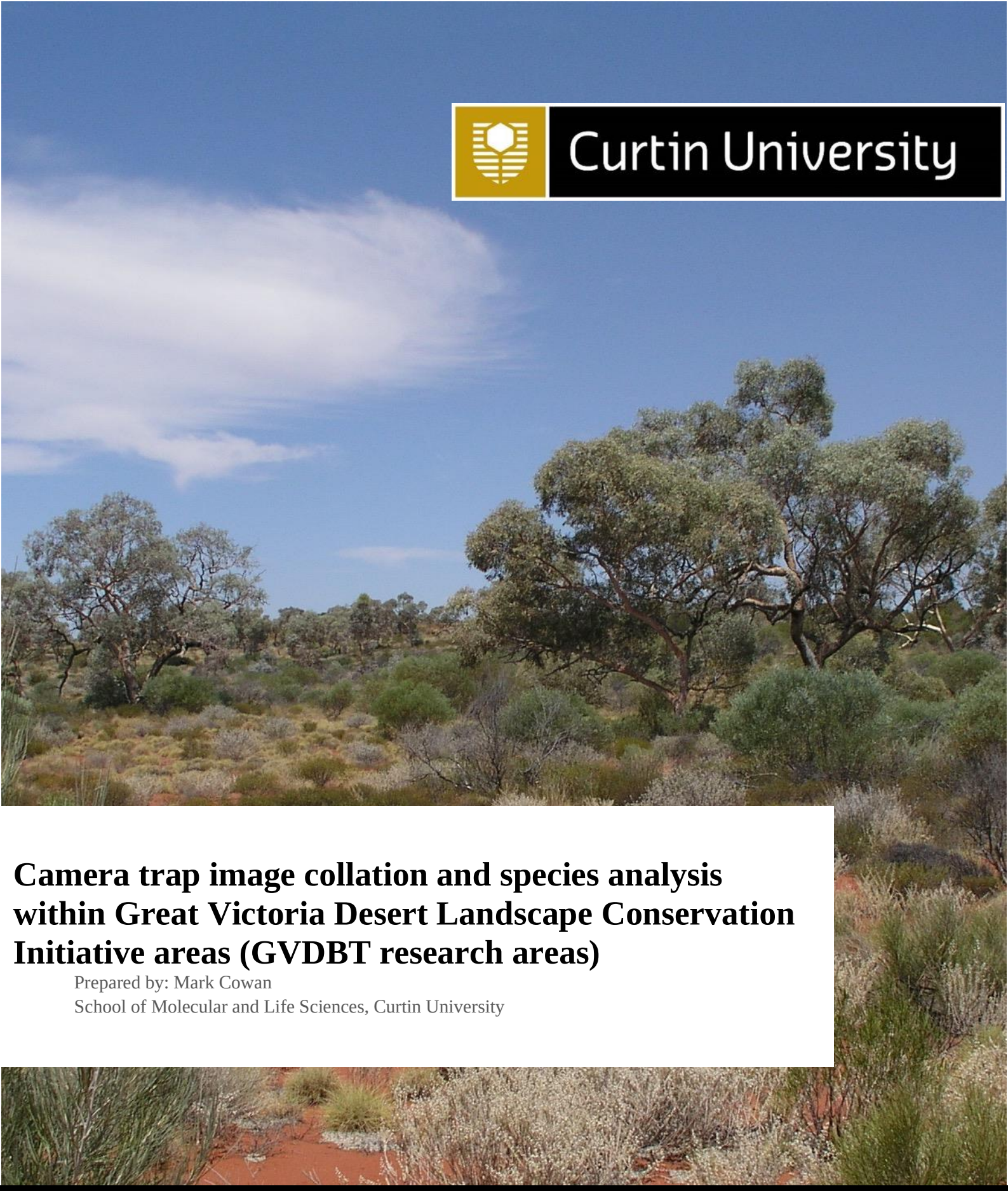

Camera trap image collation and species analysis within Great Victoria Desert Landscape Conservation Initiative areas (GVDBT research areas)

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Curtin would like to pay respect to the Aboriginal and Torres Strait Islander members of our community by acknowledging the Traditional Owners of the land on which the Perth campus is located, the Whadjuk people of the Noongar Nation; and the Wongutha people of the North-Eastern Goldfields on which our Kalgoorlie campus is located. We acknowledge the Traditional Owners, their ancestors, Elders, and emerging for their stewardship of Country.

Image credit: Talouse.com.au/investment

REPORT INFORMATION

- Project Name: Camera trap image collation and species analysis within the Great Victoria Desert landscape conservation initiative area.
- Date of report completion: 11th October 2024
- Report Author(s): Mark Cowan, Curtin University
- Project Proponent(s): Great Victoria Desert Biodiversity Trust Management Panel

KEY FINDINGS

• **Sandhill Dunnart Detection**: There are new locations in the reference area for sandhill dunnarts but due to difficulties in identification they require further investigation.

• **Feral Cat Detection**: Although still relatively few, feral cats were more frequently detected off-track than on-track, and this has been the same across both survey periods.

• **Low Detection Rates and High Variability**: As previously noted, detection rates were low for most species, and significant variability between surveys highlights the challenges in using this data for tracking biodiversity changes, except for common species like camels and dingoes/dogs.

• **Species Dominance**: Only large and wide-ranging species such as camels, dingoes/dogs and grey kangaroos were frequently detected, further illustrating the limitations of the current camera deployment strategy for tracking broader biodiversity patterns.

• **Off-Track Cameras Capture More Diversity**: Off-track camera deployments provided more diverse and heterogeneous species data.

• **Limited Independent Animal Detections**: A total of 997 independent animal detections were recorded across the 85 functioning cameras, averaging 11.7 independent detections per camera (SD = 10.5). This underscores the low detection rates across the survey area, particularly for less common species.

• **High Rate of False Detections**: Of the 52,701 total images captured, 84% (44,161) were identified as false detections, highlighting a significant issue with camera sensitivity or placement. Only 8,540 images contained positive species detections, averaging 100.5 images per camera (SD = 133.5).

• **Camera Failures**: Technical issues impacted data collection, with 11 cameras providing no data and 27 yielding incomplete datasets due to battery failures or other malfunctions. These issues were more prevalent among infrared on-track cameras, particularly in the Reference Area, where more than half of the cameras failed to collect complete data.

• **Off-Track Cameras More Reliable**: Off-track white flash cameras showed better reliability, with most remaining operational throughout the 245-day deployment period. In contrast, on-track cameras, particularly in the RA, experienced more frequent malfunctions.

CONTEXT

This report represents the second assessment of the Great Victoria Desert Biodiversity Trust's (GVDBT) camera trap program in the Great Victoria Desert (GVD). It summarises the second round of data collection and provides an evaluation of all data collected from the project to date. Since May 2022, ninety-six remote camera traps have been deployed in two distinct areas of the GVD, each covering approximately 30 km by 30 km. These areas are designated as the Reference Area (RA) and the Management Area (MA). The RA is located adjacent to the south-western boundary of the Plumridge Lakes Nature Reserve, while the MA is approximately 23 km east of the Queen Victoria Spring Nature Reserve. The north-eastern corner of the MA lies about 20 km from the southwestern corner of the RA.

The purpose of these two areas is to enable a before-after-control-impact (BACI) experimental design on a landscape scale. Planned manipulations in the MA may include fire regime modifications and introduced predator management. In contrast, the RA will serve as a control area with no planned interventions. The cameras aim to establish a baseline understanding of biodiversity in both areas, focusing on conservation-significant species such as malleefowl, sandhill dunnarts, and mulgara, as well as introduced predators and herbivores.

In each area, 25 infrared flash cameras are positioned along track edges with a spacing of over 3 km, while 23 white flash cameras are placed off-track in long-unburnt vegetation with a spacing of over 1.5 km. The initial data assessment took place between camera installation in May 2022 and the first servicing in August 2023, approximately 16 months post-installation.

This report presents the most recent camera trap data and, combined with the previous round of imagery, provides individual site assessments as well as collective analyses of on-track and off-track data within the RA and MA. A particular focus is placed on conservation-significant species and introduced species. As in the previous analysis, the data has been integrated into the CPW PhotoWarehouse database, enabling the viewing of collated camera trap imagery, generation of reports, and data exports. Additionally, a link to a web-based application (Cowan 2017) that facilitates spatial and temporal analysis of the data is provided for further exploration.

DATA COLLATION

Camera trap data were provided on a hard drive, organised with a single folder for each camera. Of the 96 cameras deployed, data were available from only 85. Among the 11 cameras without data, three were missing from the field, one could not be recovered due to flooding, one malfunctioned (continuous shutter activation), one was set to a 5-second time-lapse and its card filled, one camera failed to arm, and four others had no data for undetermined reasons. The cameras were deployed for approximately 245 days (from 24th August 2023 to 25th April

2024), which is just over half the duration of the previous survey period of 475 days. In total, 52,701 images were collected.

The data collation methods mirrored those used in the previous survey assessment. Images were processed using Megadetector AI software (Beery et al., 2019), applying a threshold of 10% or greater probability to distinguish images with animals from those without. To eliminate false negatives, images flagged as false detections were manually reviewed using FastStone Image Viewer (FastStone, 2023), and any images containing animals were moved back to the appropriate positive image folders. False positives did not require intervention at this stage, as they are identified during the database entry process.

Typically, sequences of images captured in quick succession (<10 seconds apart) depict the same individuals—such as a kangaroo grazing in front of a camera or a dingo inspecting the device. To refine the dataset, we extracted time sequences from the embedded image EXIF data using R (R Core Team, 2024). This process involved selecting the single image with the highest probability of depicting an animal (as determined by Megadetector) from each sequence of images taken less than 10 seconds apart. This final subset of data was then uploaded to the database, with species identified for each image along with the corresponding camera, date, and time. Once this subset was complete, identification details were transferred back to the other images within the same time sequence, and these data were also uploaded to the database. R scripts facilitated these activities.

The capture and management of all camera trap imagery and associated data continue to be handled through CPW PhotoWarehouse (Newkirk, 2016). Data from this survey period were added to the database established during the initial survey period.

RESULTS- OVERVIEW

While the original number of images from all camera traps was 52,701, 84% (44,161) were identified as false detections. The false detections for each camera are illustrated in Figure 1. A total of 8,540 positive detections were recorded from the 85 cameras assessed, resulting in an average of 100.5 images per camera (SD = 133.5), as shown in Figure 2. The number of independent animal detections (defined as a single detection of any species on any camera within a 24-hour period) is plotted in Figure 3. A total of 997 independent animal detections were recorded, with an average of 11.7 detections per camera (SD = 10.5).

As previously mentioned, 11 cameras did not provide any data due to various issues, and an additional 27 cameras yielded incomplete datasets because of battery failures or other malfunctions during the survey period (Figure 4). These issues were most prevalent among the infrared on-track cameras, with 13 of the 21 functioning cameras in the RA area providing incomplete datasets—more than half. In the MA area, 10 out of 20 on-track cameras also had incomplete datasets, representing half of the cameras in that area.

In contrast, most off-track white flash cameras remained operational for the entire 245-day deployment, with only one malfunctioning in the MA and three in the RA. Overall, of the 96 cameras deployed, full datasets were available for only 59 cameras.

When assessing species detections, it is important to define the timing used to establish independence. Extensive analysis of camera trap datasets by the author has shown that for most species, particularly those that are rare or infrequently encountered, a single detection per camera per 24-hour period is not significantly different from using shorter intervals, such as one hour or less. In fact, for many species, there is no difference at all. This is because most animals do not repeatedly traverse the same area within short timeframes, and when multiple detections occur in quick succession, they typically involve the same individual(s). Therefore, throughout this report, a 24-hour period is used to define independence for detection rates, unless otherwise stated.

An assessment of these timeframes for all identified mammal species from the entire dataset (April 2022 to August 2024) is provided in Figure 5.

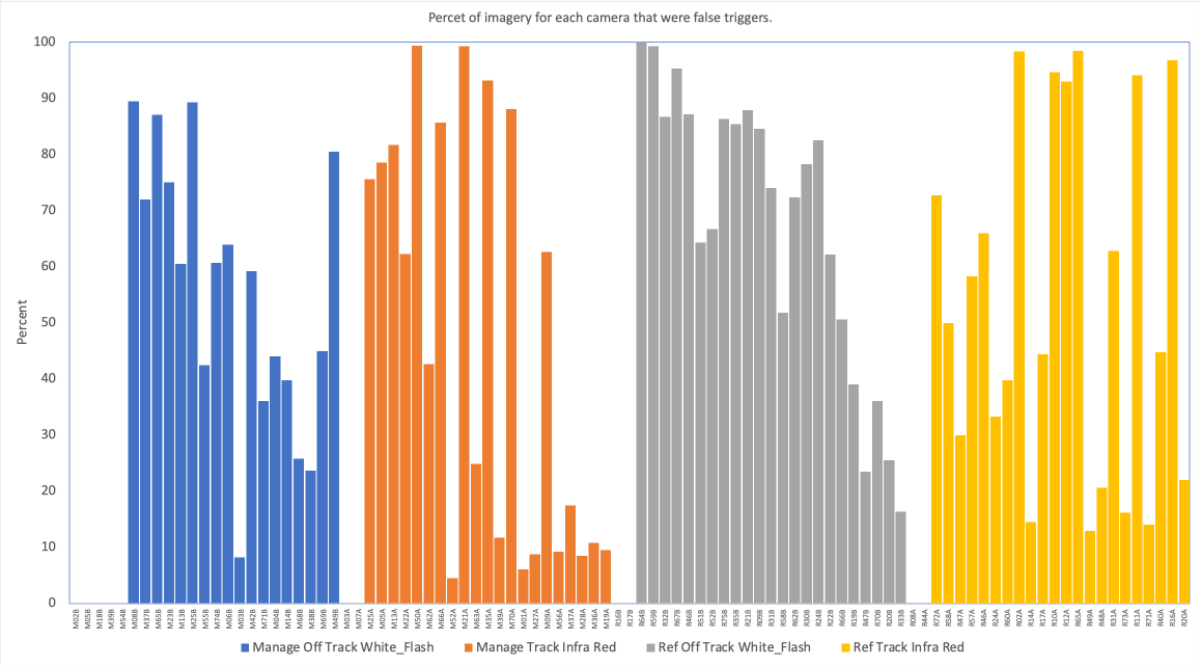


Figure 1 False detections as a percent of the overall imagery taken for each camera during this survey period.

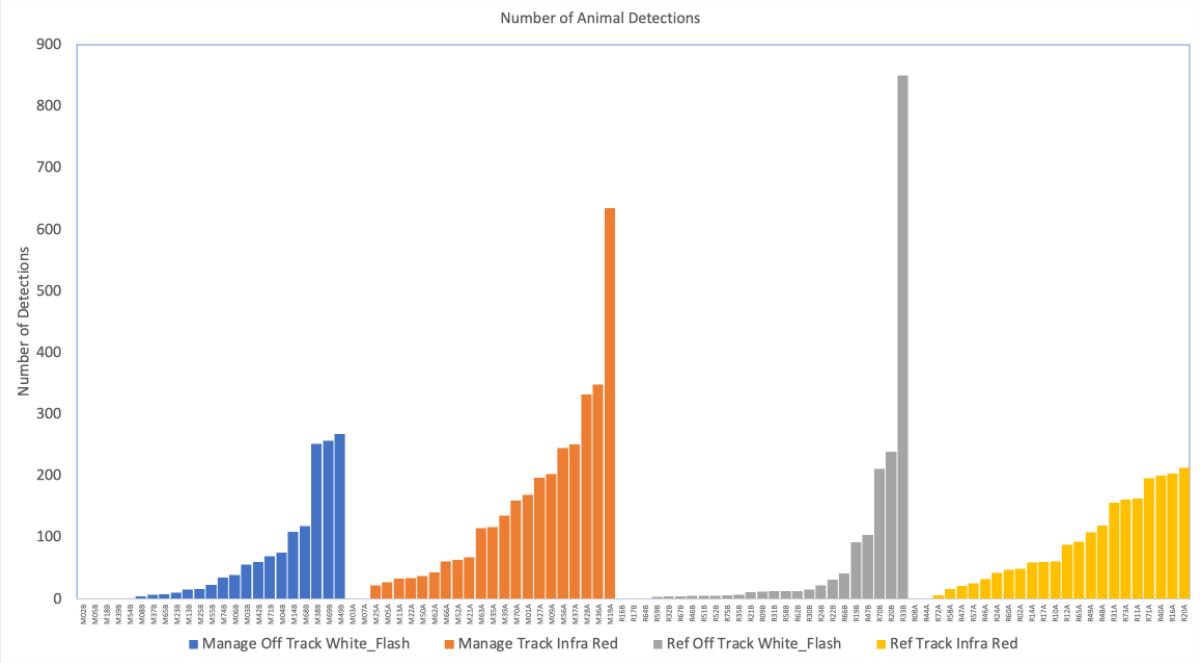


Figure 2 Number of positive detections for each camera during this survey period.

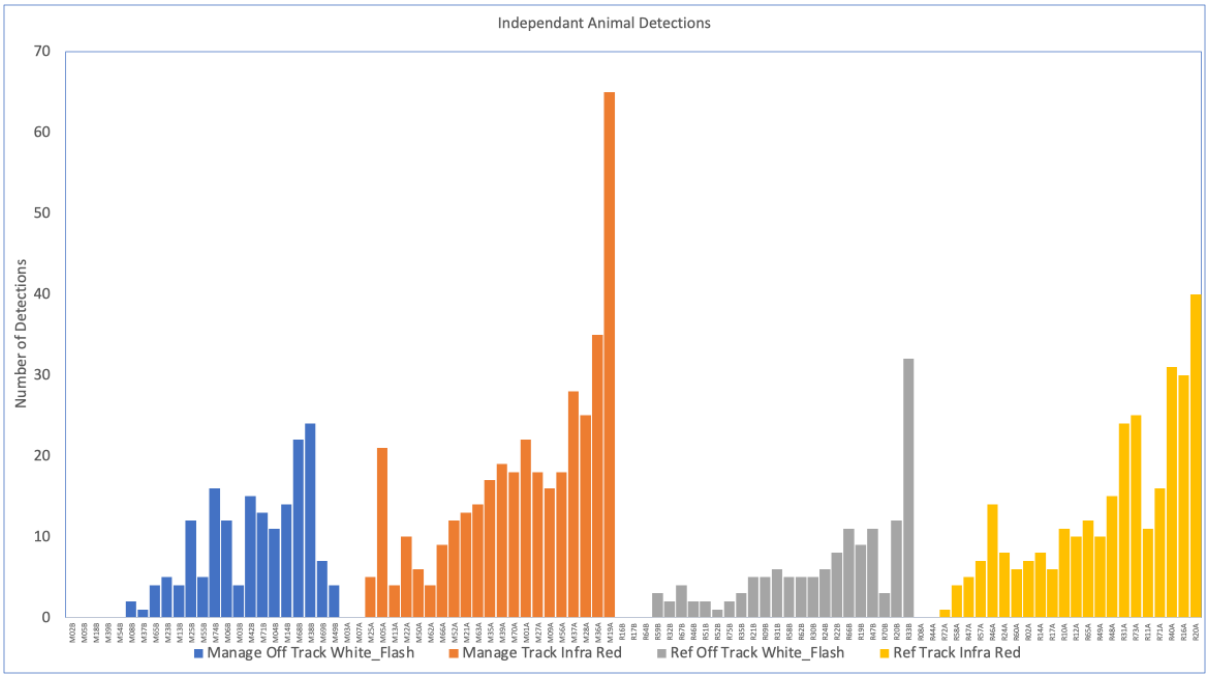


Figure 3 Number of animal detections for each camera.

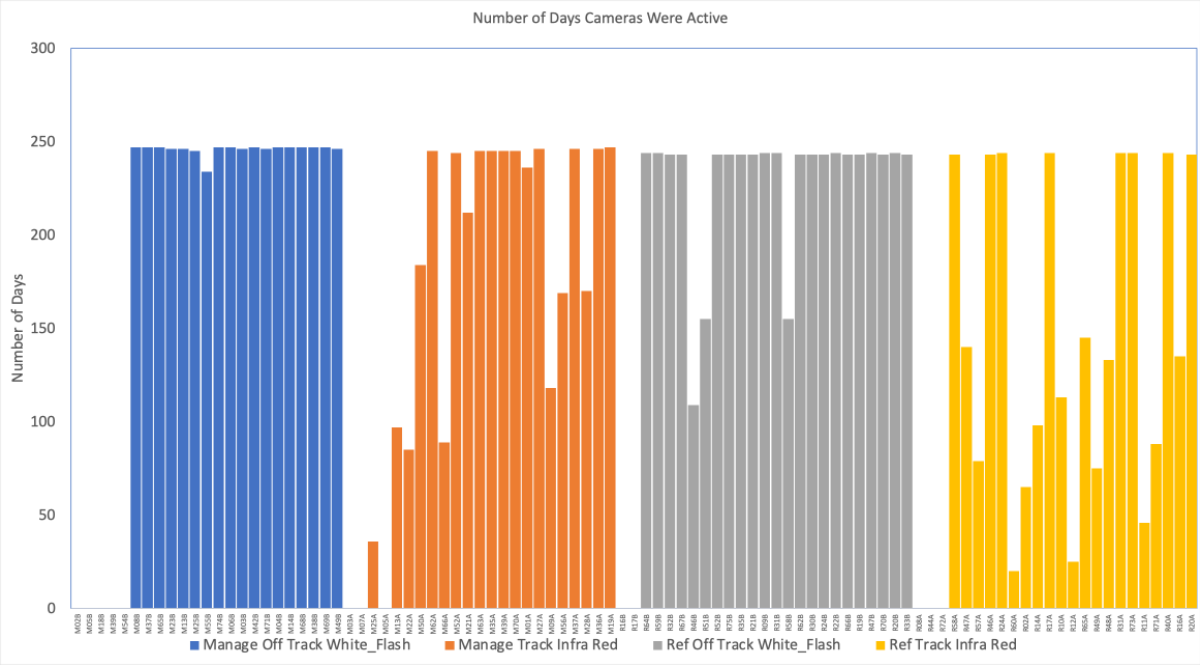
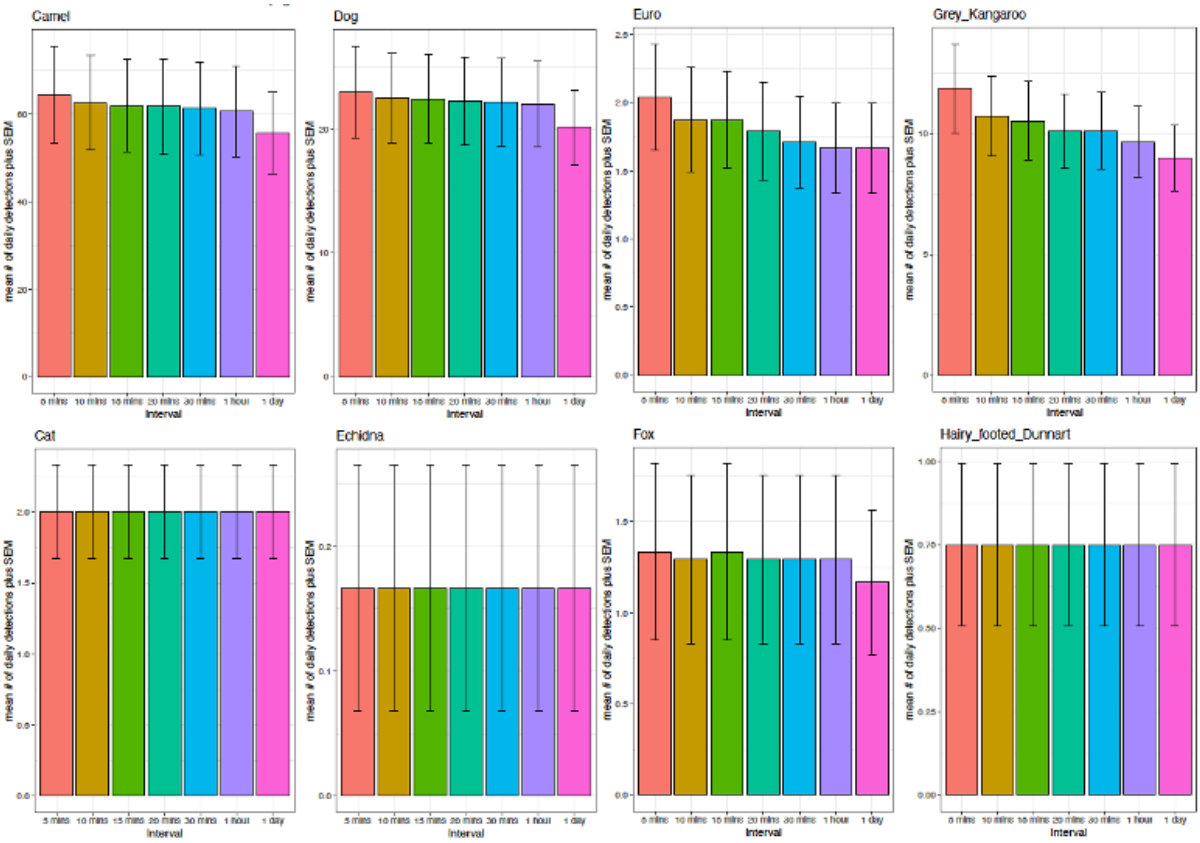


Figure 4 Number of days each camera was active during the survey period.



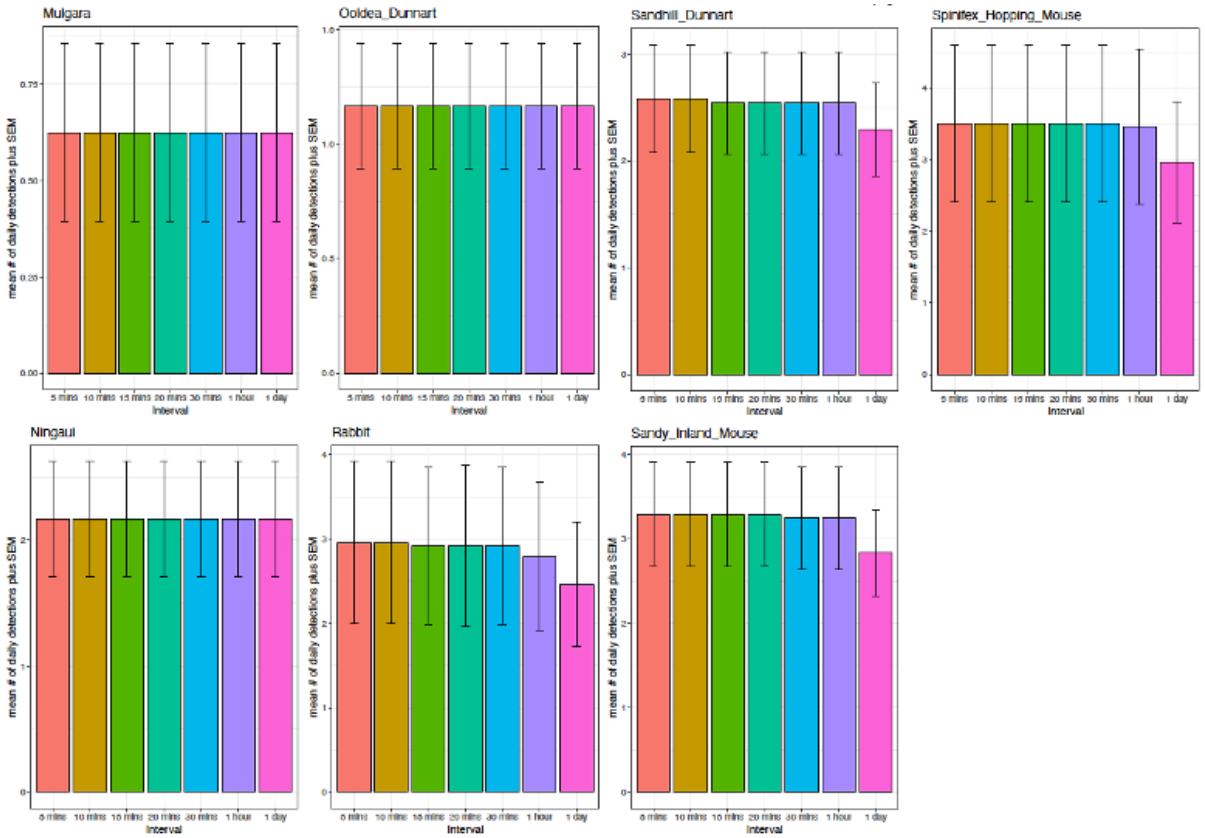


Figure 5 Difference in detection rates ranging from five minutes to 24 hours for all mammals species identified.

RESULTS-ANIMALS

During this survey period, 29 species were identified, including 12 bird species, 12 mammal species, and 5 reptile species. This contrasts with the first survey, which identified 46 species: 25 birds, 15 mammals, and 6 reptiles. Notably, the fox, echidna, and hairy-footed dunnart were detected in the first survey but absent in the second.

In both surveys, a small number of images could not be identified at the species level: 64 in the first survey and 43 in the second. These figures exceed the actual number of detections, as at least three images were captured per detection. While summary detection data for mammals, birds, and reptiles are presented in Tables 1 and 2, the thermal signatures, size, and behaviour of reptiles and birds make them less reliably detected by cameras compared to mammals. Therefore, aside from conservation-significant species such as malleefowl, the remainder of this report focuses on the mammal fauna.

During this survey, three introduced species were detected: camel, feral cat, and rabbit, along with the dingo/wild dog. Only two conservation-significant species were identified: the brush-tailed mulgara and the sandhill dunnart. Table 1 provides an overview of all independent detections from both survey periods, detailing all species and their respective study areas.

Similar to the previous survey round, overall mammal species richness was markedly higher off-track (15 species) in both the RA and MA compared to on-track (6 species), where large

mammals were the primary species detected. For introduced species, camels and dingoes/dogs had significantly higher detection rates on-track (478 and 118, respectively) compared to off-track (8 and 5, respectively). Camel detections were high in both the RA (185) and the MA (301), while dingoes/dogs were detected more than twice as often in the RA (87) than in the MA (36). Feral cat detections were comparatively few in all areas (16), although detections were significantly higher off-track (14) than on-track (2). Foxes were not detected during this survey. Rabbits were only detected off-track (10), with 6 in the RA and 4 in the MA.

Regarding conservation-significant species, no malleefowl were detected during this survey period. In the previous survey, only two were detected on-track and one off-track, all within the same general area of the MA. There were seven detections of mulgara, all occurring off-track in the MA. Sandhill dunnarts were recorded 26 times off-track, with 18 detections in the MA and 6 in the RA. Caution is warranted regarding new detections of sandhill dunnarts, especially in the RA, as they were not recorded in the first survey, and identification challenges exist with camera trap imagery. These sites require further investigation.

Table 1. Detections of fauna that were identified from camera traps on track and off track in both the management area and the reference area. This covers both survey periods with / delimiting detections in the first survey from those in the second or current survey.

Common Name	reference area off track	management area off track	reference area on track	management area on track	Total
Bearded Dragon	1/0	5/3			**9**
Black Tree Monitor	2/4	7/11			**25**
Bustard				1/0	**1**
Camel	7/3	4/5	589/182	495/296	**1581**
Cat	7/11	16/3	6/1	3/1	**48**
Chestnut-breasted Quail-thrush	7/1	1/0		1/0	**10**
Chestnut-rumped Thornbill		1/0			**1**
Crested Bellbird	18/10	15/2	2/0		**47**
Crested Dragon	0/1		1/0		**2**
Crow	0/1			1/0	**2**
Currowong	18/11	61/16	1/2	2/0	**111**
Dog	18/4	2/1	247/83	126/35	**516**
Echidna	2/0	1/0	1/0		**4**
Emu				3/3	**6**
Euro	21/14		1/2	2/0	**40**
Fox	3/0		25/0		**28**
Gilberts Whistler		1/0			**1**
Goulds Sand Goanna	17/10	17/23	0/1	2/0	**70**
Grey Butcherbird	9/2	6/0	1/0		**18**
Grey Kangaroo	52/10	52/20	50/10	23/9	**226**
Grey Shrike-thrush	2/0				**2**
Hairy-footed Dunnart	14/0	4/0			**18**

Common Name	reference area off track	management area off track	reference area on track	management area on track	Total
Hooded Robin		3/0			**3**
Magpie	1/1	3/0	1/0	1/5	**12**
Malleefowl		1/0		2/0	**3**
Mulgara		8/7			**15**
Ningaui	2/5	29/17			**53**
Ooldea Dunnart	16/0	7/5			**28**
Owlet Nightjar	1/2	1/0	0/1		**5**
Pied Butcherbird	4/0	1/0			**5**
Pygmy Desert Monitor	1/0	2/0			**3**
Rabbit	48/6	1/4			**59**
Red-capped Robin	1/2	0/5			**8**
Redthroat	1/0				**1**
Sandhill Dunnart *	0/8	30/18			**56**
Sandy Inland Mouse	3/4	60/1			**68**
Short-tailed Grasswren		1/0			**1**
Spinifex Hopping Mouse	68/0	1/2			**71**
Splendid Fairy-wren	2/0		0/1		**3**
Spotted Nightjar	1/0	1/0			**2**
Striated Pardalote	1/0				**1**
Tawny Frogmouth	1/0	1/0			**2**
Thorny Devil	2/1	4/0			**7**
Wedge-tailed Eagle		1/0			**1**
White-browed Babbler	2/0	1/0			**3**
Willie Wagtail		0/1			**1**
Grey Teal	0/1				**1**
Yellow-throated Miner	1/0	5/0			**6**
Total	**354/134**	**354/165**	**925/283**	**662/349**	**3226**

The proportion of cameras that detected each species—on-track and off-track, in both the RA and MA—as well as the overall proportion of all cameras combined for the entire survey period from May 2022 to August 2024, is presented in Table 2.

For species of conservation significance, sandhill dunnarts were detected on 6% of all cameras, with 16% in the RA and 9% in the MA. Mulgara were detected on 5% overall, with 22% in the MA, while malleefowl were detected on 2% overall, with 4% on-track and off-track in the RA.

Camels, dingoes/dogs, and grey kangaroos were detected on more than 58% of all cameras, though this varied between the RA and MA, and between on-track and off-track. Camels were detected on 100% of on-track cameras but on very few off-track cameras. Dingoes/dogs were detected on more than 90% of on-track cameras, but fewer off-track: 9% in the MA and 40%

in the RA. Grey kangaroo detection rates ranged from 52% to 79%, with an overall rate of 68%.

Foxes were recorded on only 7% of the total cameras, all in the RA. Feral cats were detected on 20% of cameras across all areas, with higher detection rates off-track (MA = 39% and RA = 20%) compared to on-track (MA = 9% and RA = 13%). Rabbits were detected on 7% of cameras overall, all off-track.

Table 2. Proportion of cameras within the different treatments on which each species was detected. This covers the entire time camera were in the field.

Common Name	reference area off track	management area off track	reference area on track	management area on track	Total
Bearded Dragon	4	22			**6**
Black Tree Monitor	24	48			**18**
Bustard				4	**1**
Camel	28	35	100	100	**65**
Cat	20	39	13	9	**20**
Chestnut-breasted Quail-thrush	24	4		4	**8**
Chestnut-rumped Thornbill		4			**1**
Crested Bellbird	48	39	4		**23**
Crested Dragon	4		4		**2**
Crow	4			4	**2**
Currowong	40	43	13	4	**25**
Dog/Dingo	40	9	92	91	**58**
Echidna	8	4	4		**4**
Emu				17	**4**
Euro	20		8	4	**8**
Fox	12		17		**7**
Gilberts Whistler		4			**1**
Goulds Sand Goanna	40	74	4	9	**32**
Grey Butcherbird	28	22	4		**14**
Grey Kangaroo	64	78	79	52	**68**
Grey Shrike-thrush	8				**2**
Hairy-footed Dunnart	8	9			**4**
Hooded Robin		4			**1**
Magpie	4	9	4	4	**5**
Malleefowl		4		4	**2**
Mulgara		22			**5**
Ningaui	16	35			**13**
Ooldea Dunnart	24	26			**13**
Owlet Nightjar	12	4	4		**5**
Pied Butcherbird	12	4			**4**

Common Name	reference area off track	management area off track	reference area on track	management area on track	Total
Pygmy Desert Monitor	4	4			**2**
Rabbit	12	17			**7**
Red-capped Robin	12	4			**4**
Redthroat	4				**1**
Sandhill Dunnart	16	9			**6**
Sandy Inland Mouse	20	26			**12**
Short-tailed Grasswren		4			**1**
Spinifex Hopping Mouse	20	9			**7**
Splendid Fairy-wren	8		4		**3**
Spotted Nightjar	4	4			**2**
Striated Pardalote	4				**1**
Tawny Frogmouth	4	4			**2**
Thorny Devil	8	9			**4**
Wedge-tailed Eagle		4			**1**
White-browed Babbler	8	4			**3**
Willie Wagtail		4			**1**
Grey Teal	4				**1**
Yellow-throated Miner	4	17			**5**

Detection distributions for the three species of conservation significance—sandhill dunnart, malleefowl, and mulgara—from all the camera trap survey data are presented in Figures 6 to 8 below. Detection distributions for all introduced mammals across both the RA and MA from the entire survey are shown in Figures 9 to 13. All other mammal species are in Appendix A Figures 17 to 25. In all figures, green points indicate off-track cameras, while blue points represent on-track cameras. Numbers represent independent detections, and where there is no number in a point, it signifies a single detection.

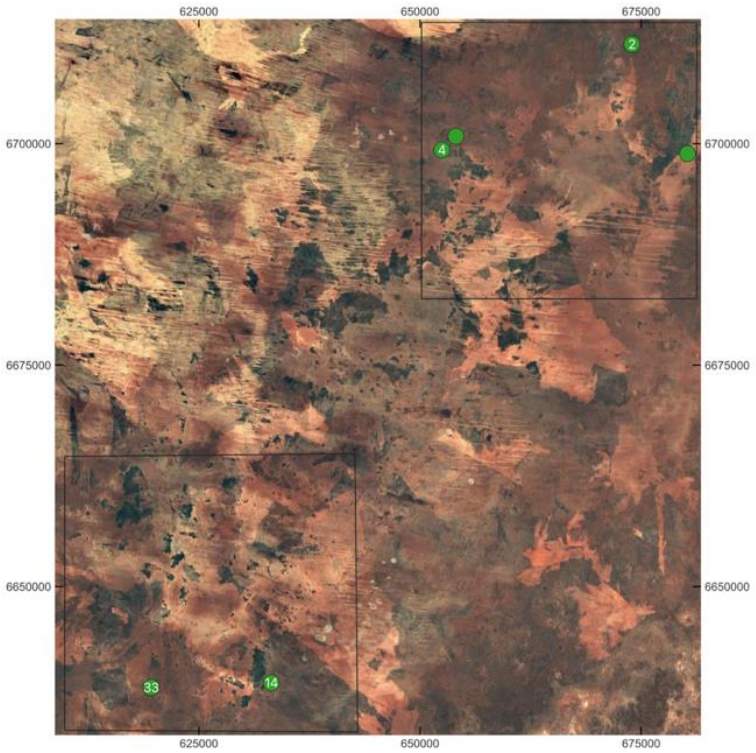


Figure 6 Sandhill Dunnart detections in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

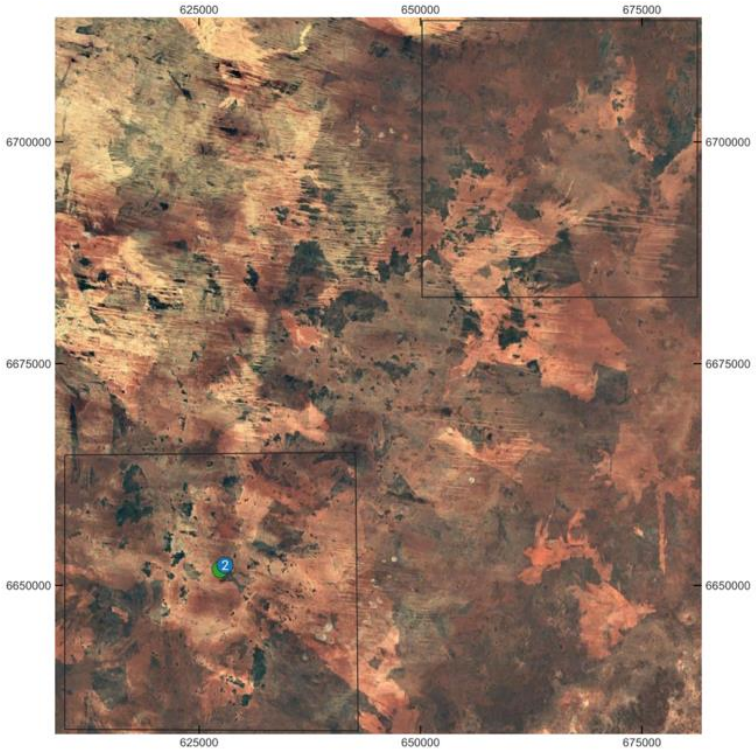


Figure 7 Malleefowl in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

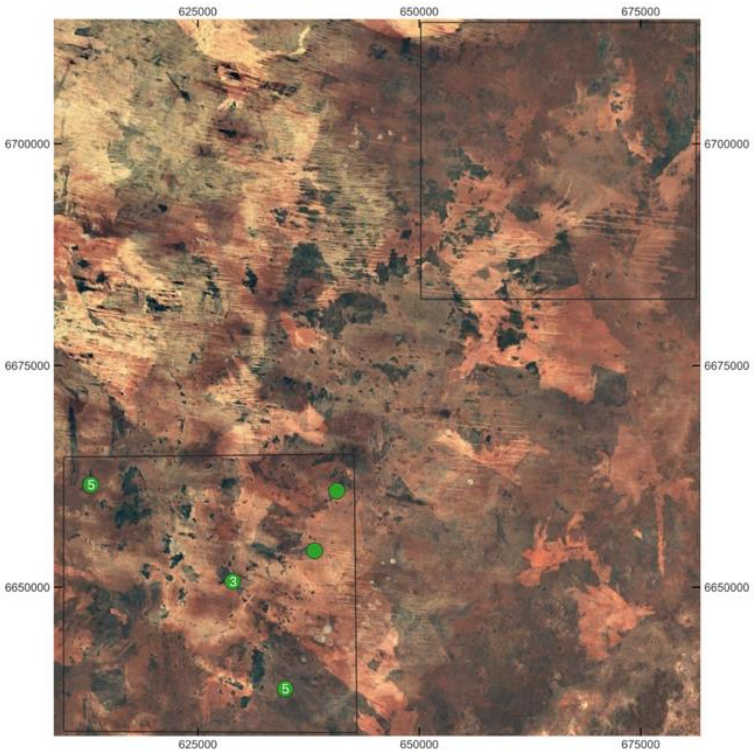


Figure 8 Mulgara in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

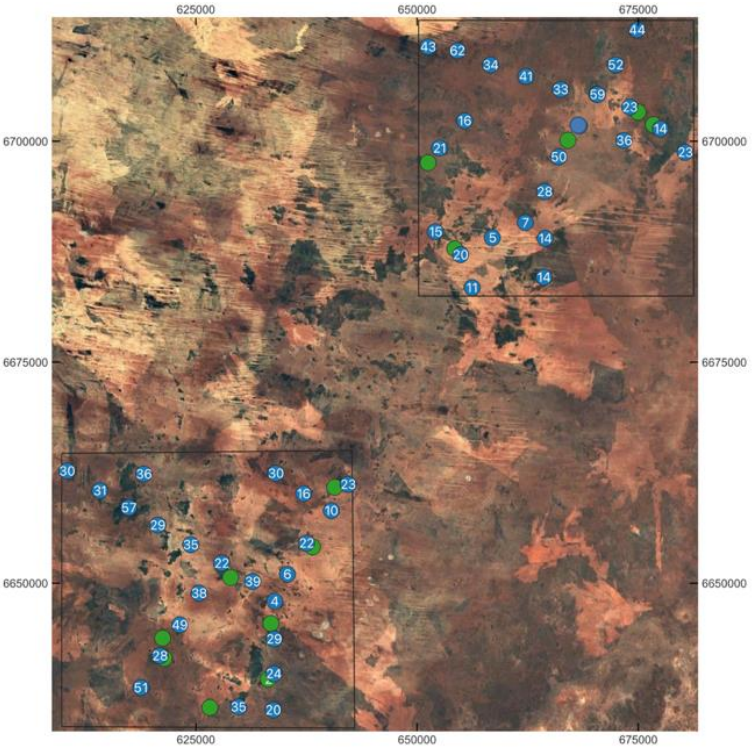


Figure 9 Camel detections in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

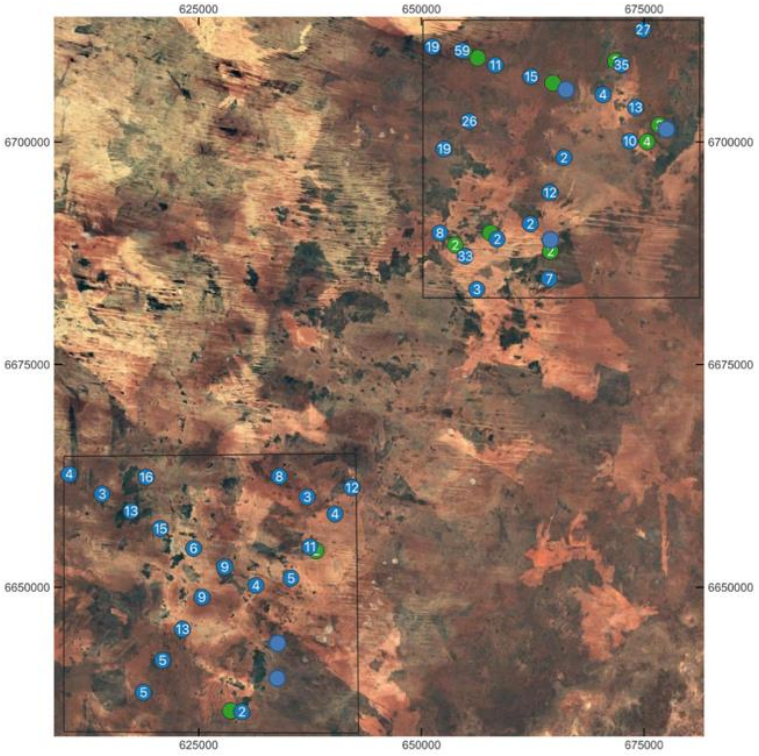


Figure 10 Dogs/Dingos detections in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

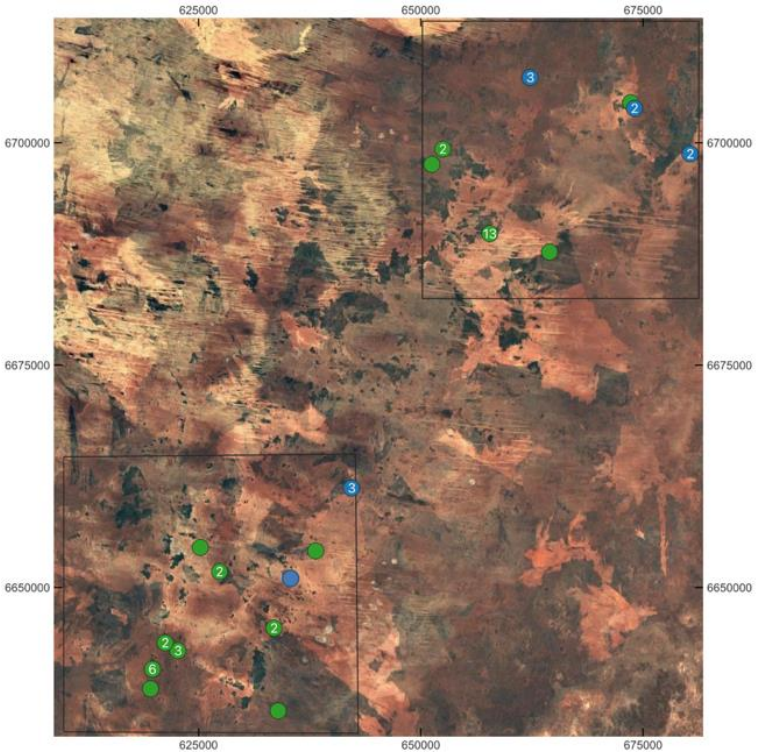


Figure 11 Cat detections in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

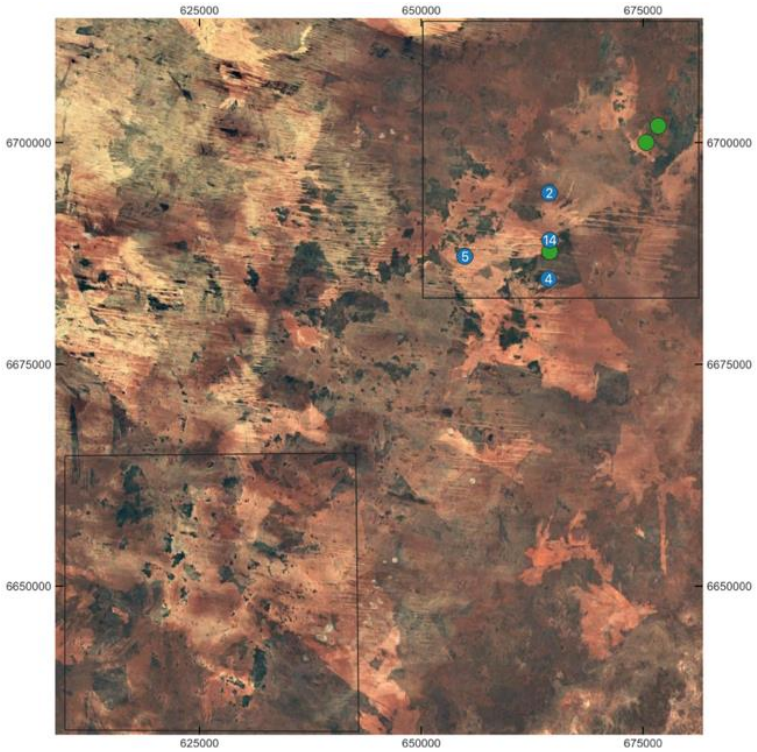


Figure 12 Fox detections in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

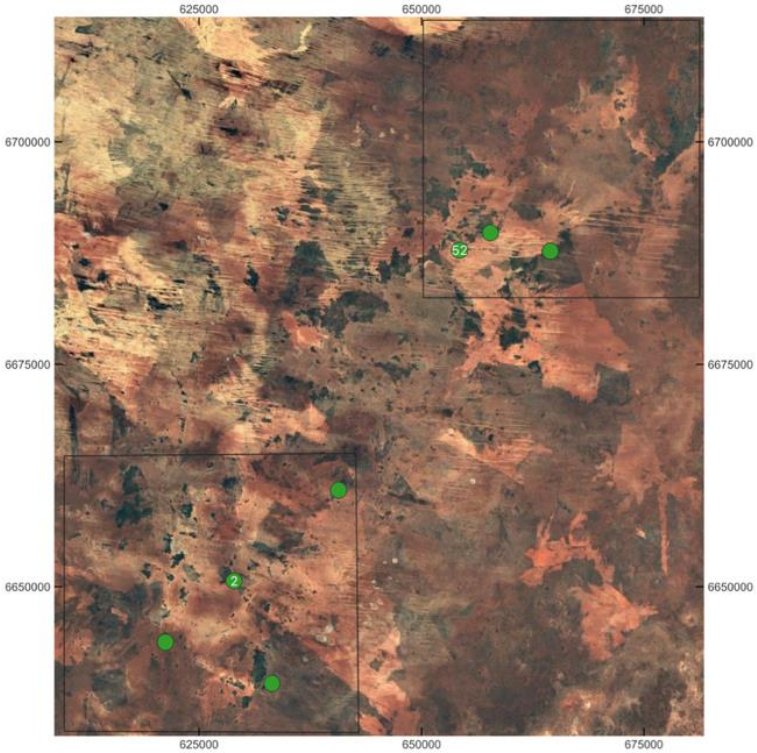


Figure 7 Rabbit detections in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

As part of the evaluation of biodiversity in the study area, we calculated two diversity indices: the Shannon-Wiener Index (D) and Pielou's Evenness Index (J'). These indices provide insights

into both the richness and evenness of species present in the environment. Data from all available cameras were analysed to calculate these values, focusing on both on-track and off-track locations.

For the on-track cameras, the average number of species detected was relatively similar in both the management area (mean = 2.36, SD = 1.22) and the reference area (mean = 2.36, SD = 1.60). The Shannon-Wiener Index (D) for the on-track management area was 0.61 (SD = 0.44), while for the reference area, it was 0.70 (SD = 0.59). Pielou's Evenness Index (J') values were 0.58 (SD = 0.38) for the management area and 0.50 (SD = 0.41) for the reference area.

For the off-track cameras, the average number of species detected was 2.57 (SD = 0.79) in the management area and 3.13 (SD = 0.90) in the reference area. The Shannon-Wiener Index (D) for the off-track management area was 0.42 (SD = 0.21), while for the reference area, it was 0.58 (SD = 0.25). Pielou's Evenness Index (J') values for the off-track cameras were 0.52 (SD = 0.26) in the management area and 0.60 (SD = 0.23) in the reference area.

Individual camera values are presented in Table 3 for on-track cameras and Table 4 for off-track cameras.

Table 3 number of species (S), number of individuals (N), the Shannon-Weiner Index (D) and Pielou's Evenness Index (J') for on-track cameras.

Study Area	Site	S	N	D	J'
reference on track	02A	4	57	0.742	0.8182
reference on track	08A	4	32	0.8656	0.76
reference on track	10A	5	41	1.077	0.6671
reference on track	11A	4	89	0.6684	0.5678
reference on track	12A	2	51	0.2543	0.7522
reference on track	14A	2	28	0.3001	0.3712
reference on track	16A	4	51	0.763	0.7642
reference on track	17A	2	14	0.3789	0.7496
reference on track	20A	3	79	0.4577	0.747
reference on track	24A	3	26	0.6139	0.697
reference on track	31A	3	93	0.4412	0.6522
reference on track	40A	4	69	0.7085	0.8102
reference on track	44A	3	20	0.6676	0.4717
reference on track	46A	3	45	0.5254	0.7102
reference on track	47A	3	12	0.8049	0.6567
reference on track	48A	3	54	0.5014	0.6621
reference on track	49A	3	60	0.4885	0.2097
reference on track	57A	4	26	0.9208	0.7934
reference on track	58A	3	12	0.8049	0.9206
reference on track	60A	4	72	0.7015	0.5726
reference on track	65A	2	39	0.273	0.172
reference on track	71A	3	153	0.3976	0.6626
reference on track	72A	1	1	****	****

Study Area	Site	S	N	D	J'
reference on track	73A	3	73	0.4662	0.3062
management on track	01A	2	53	0.2519	0.9052
management on track	03A	3	42	0.5351	0.4319
management on track	05A	2	32	0.2885	0.8571
management on track	07A	4	58	0.7388	0.6464
management on track	09A	3	65	0.4791	0.4836
management on track	13A	1	4	0	****
management on track	19A	3	57	0.4947	0.3495
management on track	21A	3	12	0.8049	0.836
management on track	22A	2	36	0.2791	0.1831
management on track	25A	1	24	0	****
management on track	27A	3	58	0.4926	0.5272
management on track	28A	2	92	0.2212	0.6153
management on track	35A	3	33	0.572	0.8435
management on track	36A	3	76	0.4618	0.5407
management on track	37A	3	43	0.5317	0.2707
management on track	39A	4	58	0.7388	0.6236
management on track	50A	2	39	0.273	0.4771
management on track	52A	2	36	0.2791	0.4138
management on track	56A	2	46	0.2612	0.6153
management on track	62A	2	16	0.3607	0.8113
management on track	63A	3	43	0.5317	0.5334
management on track	66A	3	29	0.5939	0.2719
management on track	70A	3	38	0.5498	0.7366

**** data was insufficient to calculate diversity measure

Table 4 number of species (S), number of individuals (N), the Shannon-Weiner Index (D) and Pielou's Evenness Index (J') for off-track cameras.

Study Area	Site	S	N	d	J'
reference off track	09B	1	2	0	****
reference off track	16B	1	1	****	****
reference off track	17B	2	2	1.443	1
reference off track	19B	3	4	1.443	0.9464
reference off track	20B	3	20	0.6676	0.359
reference off track	21B	2	10	0.4343	0.971
reference off track	22B	1	2	0	****
reference off track	24B	3	6	1.116	0.9206
reference off track	30B	3	3	1.82	1
reference off track	31B	1	1	****	****
reference off track	32B	0	0	****	****
reference off track	33B	7	75	1.39	0.7032
reference off track	35B	2	6	0.5581	0.65

Study Area	Site	S	N	d	J'
reference off track	46B	1	6	0	****
reference off track	47B	5	19	1.358	0.8577
reference off track	51B	0	0	****	****
reference off track	52B	2	2	1.443	1
reference off track	58B	1	6	0	****
reference off track	59B	3	11	0.8341	0.6914
reference off track	62B	3	8	0.9618	0.6696
reference off track	64B	3	12	0.8049	0.75
reference off track	66B	3	10	0.8686	0.9912
reference off track	67B	5	24	1.259	0.6941
reference off track	70B	2	7	0.5139	0.8631
reference off track	75B	2	4	0.7213	0.8113
management off track	02B	2	3	0.9102	0.9183
management off track	03B	1	5	0	****
management off track	04B	2	6	0.5581	1
management off track	05B	2	4	0.7213	0.8113
management off track	06B	2	36	0.2791	0.4138
management off track	08B	0	0	****	****
management off track	13B	3	9	0.9102	0.8528
management off track	14B	2	14	0.3789	0.3712
management off track	18B	1	1	****	****
management off track	23B	3	9	0.9102	0.9656
management off track	25B	2	3	0.9102	0.9183
management off track	37B	1	1	****	****
management off track	38B	4	37	0.8308	0.6694
management off track	42B	4	13	1.17	0.8691
management off track	49B	2	14	0.3789	0.7496
management off track	54B	2	44	0.2643	0.3591
management off track	55B	4	13	1.17	0.8691
management off track	65B	1	2	0	****
management off track	68B	3	17	0.7059	0.4039
management off track	69B	3	7	1.028	0.7248
management off track	71B	5	20	1.335	0.8106
management off track	74B	3	7	1.028	0.9821

**** data was insufficient to calculate diversity measure

To assess the ecological variation in mammal fauna between on-track and off-track cameras in both the management and reference areas, we applied a square root transformation to the abundance data to reduce the influence of very common species. Given that many sites had mostly zero detections for species, we incorporated a dummy variable to assist in handling this zero-inflated dataset as part of the Bray-Curtis similarity analysis.

The Bray-Curtis similarity index was then used to compare sites based on species composition. The results indicated that for the on-track cameras (Figure 14), most structure occurred at more than 80% indicating there was relatively little variability in species assemblages. In contrast, the off-track cameras (Figure 15) displayed much lower similarity among sites, with there being considerable structure at the 50% similarity level.

When data from all cameras were combined and assessed using the same method, a clear separation is apparent between on-track and off-track communities (Figure 16). The variability within the off-track cameras, both within and between the reference and management areas, highlights that the ecological communities captured by off-track cameras are not only more diverse than those from on-track cameras but also exhibit a range of species compositions that vary across individual sites/cameras.

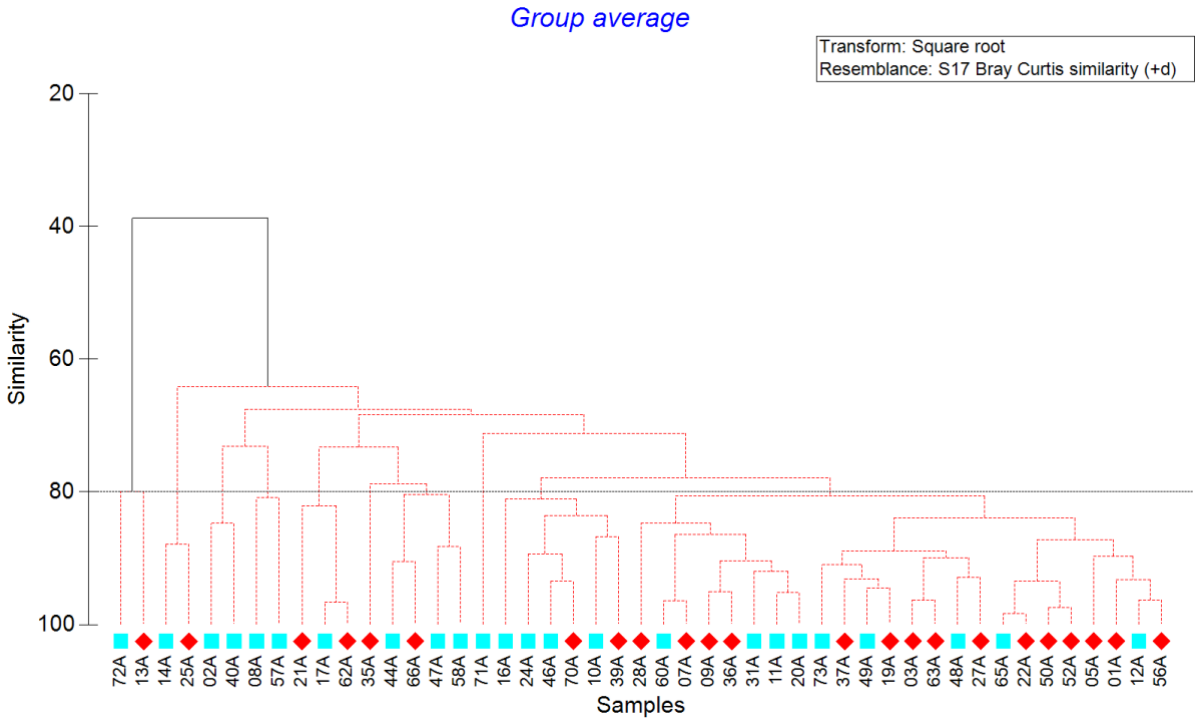


Figure 14 Similarity (Bray Curtis) of on-track cameras in the reference area (light blue squares) and the management area (red diamonds) based on relative abundance values of mammals.

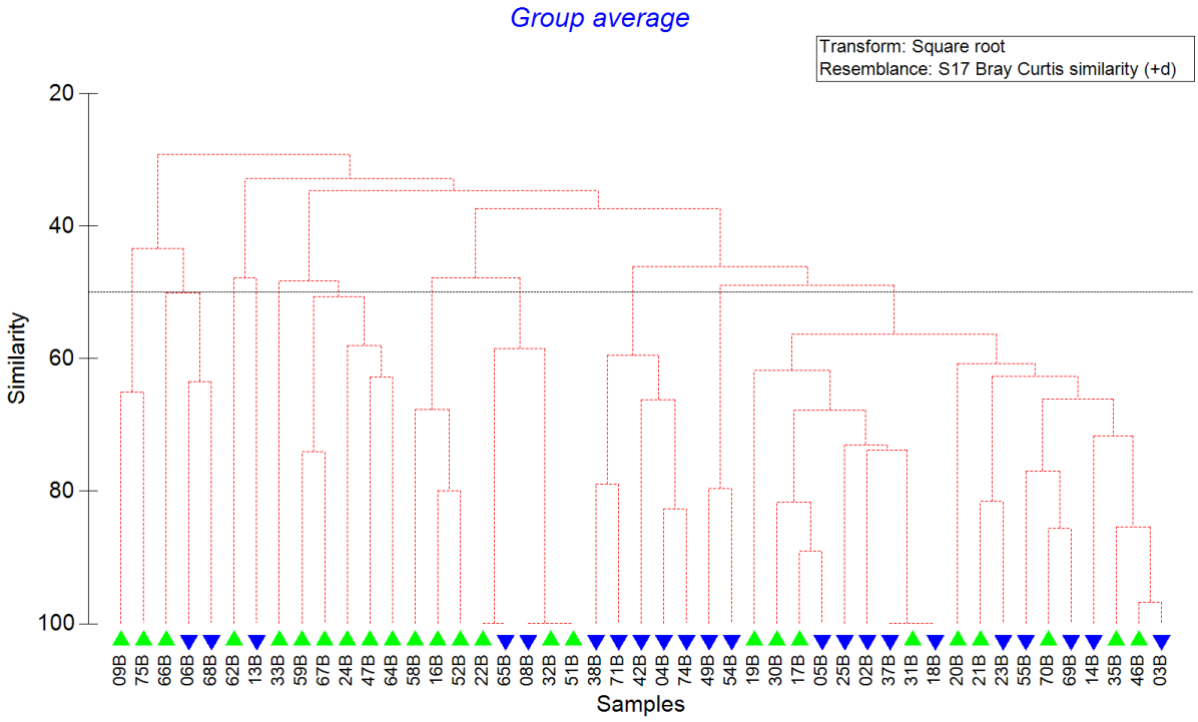


Figure 15 Similarity (Bray Curtis) of off-track cameras in the reference area (green triangles) and the management area (orange inverted triangles) based on relative abundance values of mammals.

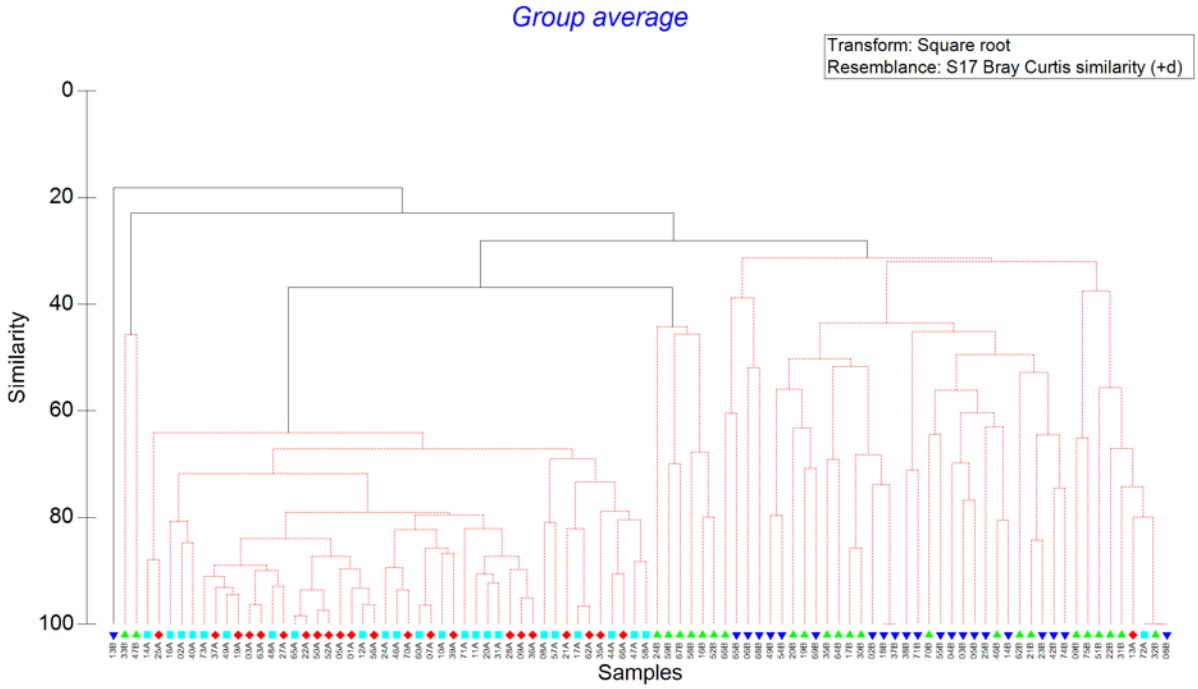


Figure 8 Similarity (Bray Curtis) of all cameras based on the relative abundance values for mammals. Light blue squares are on-track RA, red diamonds are on-track MA, green triangles are off-track RA and, dark blue triangles are off-track MA.

DISCUSSION

The results of this survey underscore significant challenges in using camera traps to monitor biodiversity in the Great Victoria Desert. One of the primary issues is the very low detection

rates of most species, compounded by variability between survey rounds and inconsistent camera performance. These limitations make it difficult to draw reliable ecological comparisons or assess population dynamics, especially for species other than the most common and widespread, such as camels and dingos/dogs.

The considerable variability in species detections, even in the absence of management interventions, points to shortcomings in the current camera trap methodology. Natural population fluctuations, animal behaviour, and environmental conditions affecting camera performance may all contribute to this variability. As a result, the data would not be robust enough to detect meaningful changes in biodiversity values or assess the impacts of future management efforts, particularly for species of conservation significance like the sandhill dunnart, mulgara, and malleefowl. Their low detection rates would limit conclusions about their responses to environmental or management interventions.

Additionally, the lack of a rigorous, reliable and standardised deployment methodology introduces further inconsistencies in the data collection process. It is not clear what the criteria were used for choosing sites for off-track cameras but this apparent lack of strategic deployment is likely contributing to the high variability in detection rates of species and their numbers across sites. This lack of standardisation complicates efforts to compare ecological outcomes between areas and reduces the effectiveness of the current setup for tracking biodiversity changes.

The species assemblage analysis identifies significant ecological differences found between on-track and off-track camera deployments. On-track cameras primarily detected large wide-ranging species like camels, dingos/dogs and grey kangaroos with high similarity in species composition across sites. In contrast, off-track cameras captured more varied and heterogeneous species assemblages, reflecting the greater ecological complexity of natural environments. The off-track cameras provide a more accurate representation of the region's mammal diversity.

Given these findings, future camera trapping efforts should focus on refining the survey design and deployment strategies. Maintaining cameras on tracks may have limited value unless the management goal is specifically to monitor common species like camels and dingoes/dogs. Instead, off-track deployments in targeted habitats, particularly for conservation-significant species and key predators like feral cats, would provide more meaningful ecological data. Notably, cats in this study of the Great Victoria Desert are more frequently detected off-track, suggesting that future surveys could prioritise off-track areas, including dune crests or drainage tracts, to better determine landscape usage.

A more structured approach to camera deployment, utilising higher-density camera arrays and incorporating both white flash and infrared technology, would allow for better monitoring of species like the sandhill dunnart, particularly in habitats where they are already suspected to occur. This habitat-specific focus, combined with improved documentation of deployment locations and more frequent servicing to address camera failures, will enhance the reliability of future data collection.

In conclusion, while the current camera trap survey provided limited utility for broad biodiversity monitoring, it has highlighted important considerations for improving future studies. Refining the primary objectives, targeting key species and habitats, and adopting a

more systematic and strategic deployment approach could help ensure that future surveys generate data that are both meaningful and actionable for management and conservation efforts in the Great Victoria Desert.

RECOMMENDATIONS

- **Review of Primary Objective:** The GVD Trust management panel should review the primary objective of camera trapping. The current deployment is of limited value for monitoring impacts from management actions, except for widespread species like camels and dingoes/dogs. This is the most important aspect of this program and was identified in the previous report also.

- **Future Use of Cameras:** Possibilities for camera placement include identifying habitats or locations where rare species, such as sandhill dunnarts, have been detected or are suspected to exist. Focusing with greater density in these areas will increase the likelihood of detecting the species and improve data collection. Similarly there could also be a greater focus on understanding more on cats and their landscape usage and how detections rates off-track might be enhanced. It is possible that targeting dune crests or other linear landscape features such as drainage tracts would further increase detections rates. Or, restricting camera deployments and increasing density to specific habitats, vegetation types and fire age that are replicated between the RA and MA.

- **Standardisation:** Deploy cameras consistently by using a ¼ inch bolt to fix the camera to a stake, ensuring a standardised height (with PIR sensors at 30 to 40 cm above ground level). Do not use cable ties for long-term camera deployments.

- **Maximising Detection Zone:** Ensure each camera's detection zone is as large as possible by minimising obstructions and ensuring moving vegetation that could interfere with performance is not in the cameras field of view.

- **Camera Settings Consistency:** Standardise camera settings by loading pre-set configurations onto the SD card before deployment. This ensures uniformity across all cameras in the survey. One option to reduce false triggers by moving vegetation is to set cameras to a schedule where they are off during the day and on at night as most false triggers occur during the day when temperature of objects is more variable. An examination of existing data would identify what the species detection implications would be for using night schedules.

- **Batteries:** Use high-quality NIMH batteries, ensuring they are fully charged prior to deployment. Record battery levels at each servicing to monitor performance and prevent camera failures due to battery depletion. Unsure the trust has an adequate number of high-quality chargers to enable concurrent charging of a large number of batteries- at least 15 to 20 charges that can charge 12 batteries at a time.

- **Camera Servicing Frequency**: Increase servicing frequency to prevent battery depletion, as high camera failure rates have impeded data collection and experimental design. Using only a night schedule may assist in reducing early battery depletion.

- **Use of Data Sheets**: Maintain detailed and up-to-date records on battery status, camera functionality, and environmental conditions. This will help identify camera issues more quickly and efficiently.

- **Training and Expertise**: Ensure that all personnel involved in camera installation and maintenance are fully trained in equipment use, data handling, and troubleshooting. At least one experienced staff member should always be part of the team to provide guidance and maintain best practices.

- **Camera replacement**: Continual deployment in extreme conditions means that cameras fail over time. Consideration should be given to purchasing a small number of cameras on an annual basis to replace cameras in the field as they fail. At least five and up to ten additional cameras should be available as replacements during each servicing trip.

LITERATURE CITED

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ADDITIONAL INFORMATION

Links to online data interrogation application:

https://ningaui.ddns.net/apps/Camera%20Trap%20Data%20Analysis/

username: gvd

password: shd

APPENDIX 1

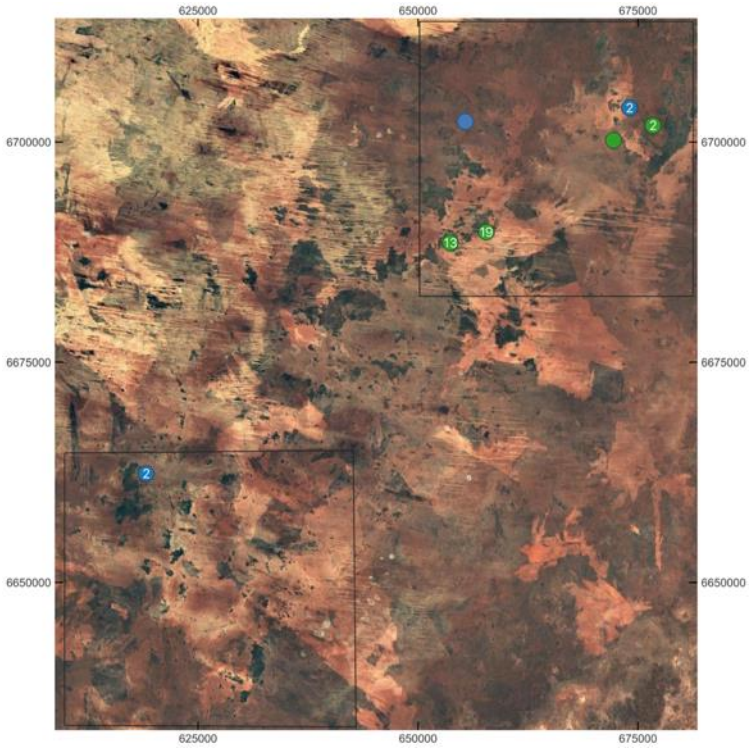

Figure 17 Euro in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

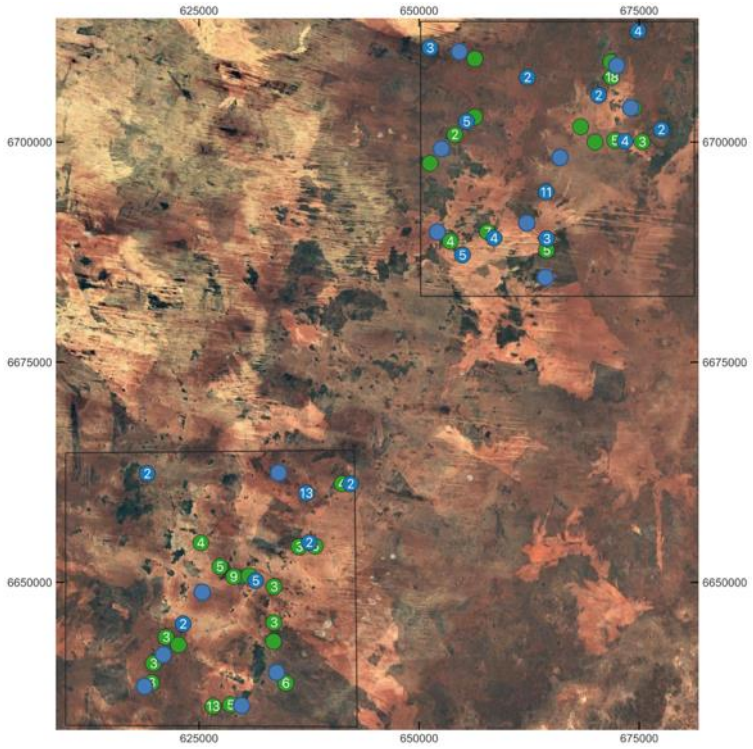

Figure 18 Western Grey Kangaroo in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

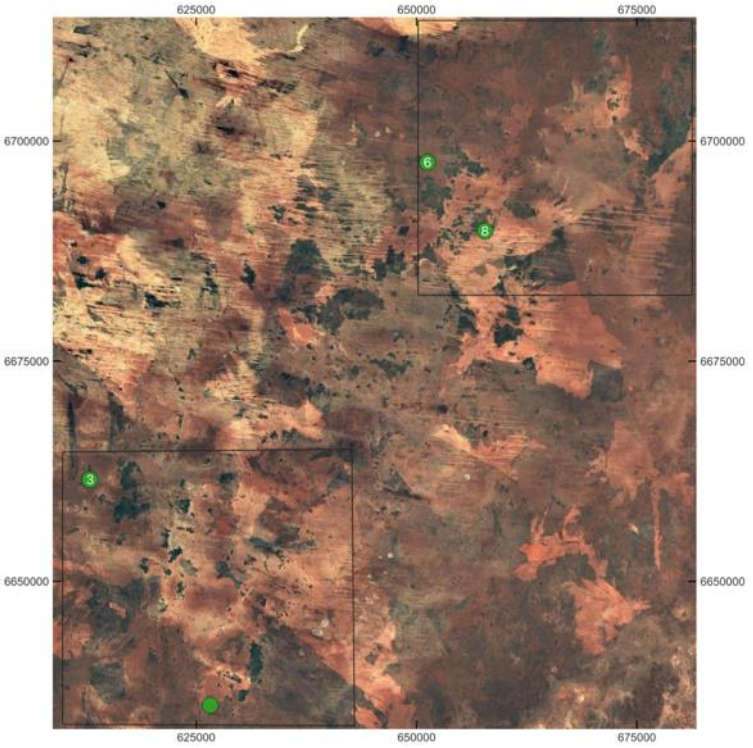

Figure 19 Hairy-footed Dunnart in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

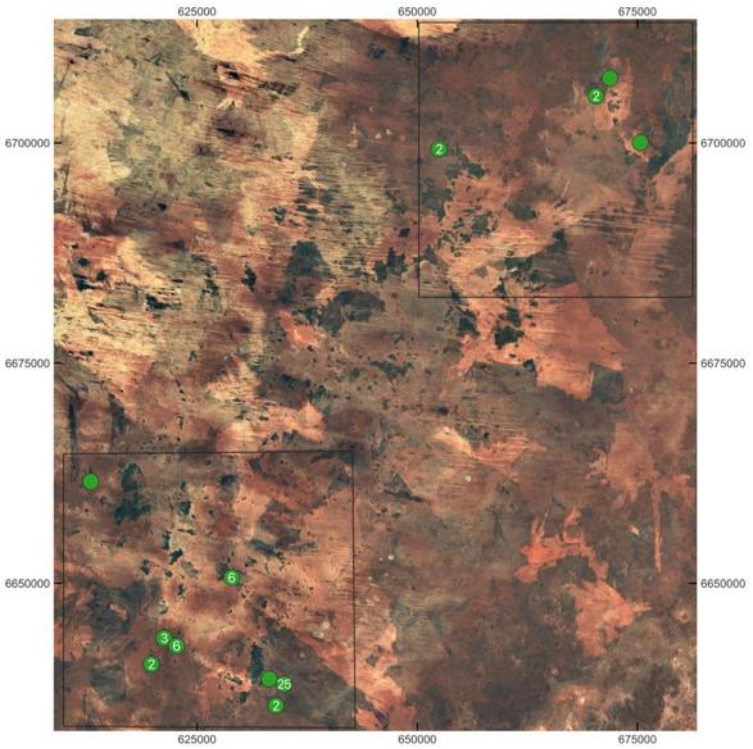

Figure 209 Ningaui in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

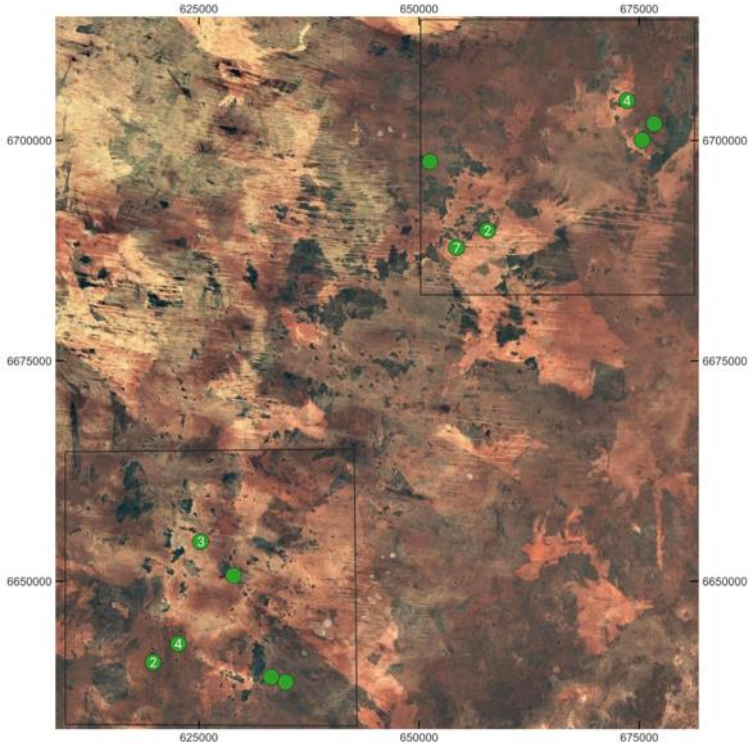

Figure 21 Ooldea Dunnart in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

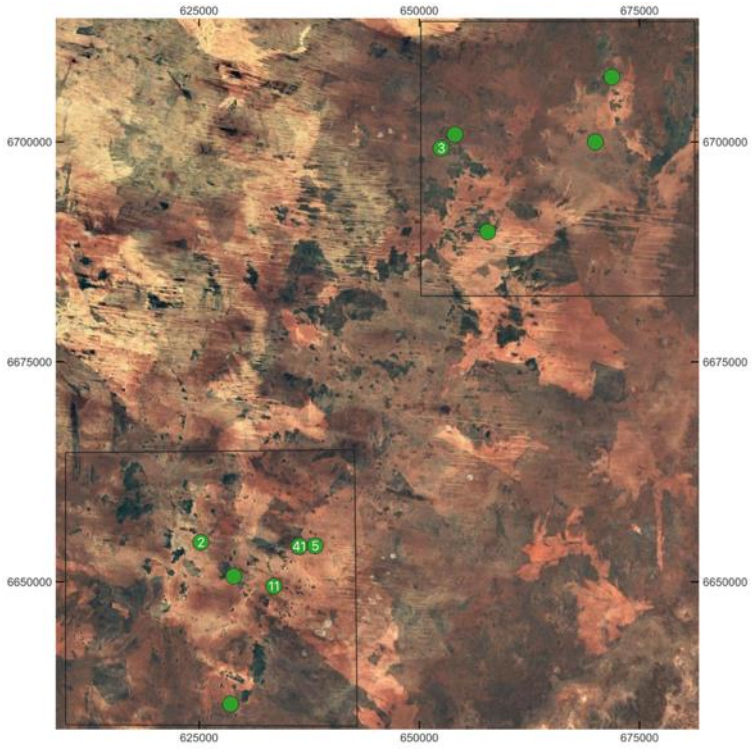

Figure 22 Sandy Inland Mouse in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

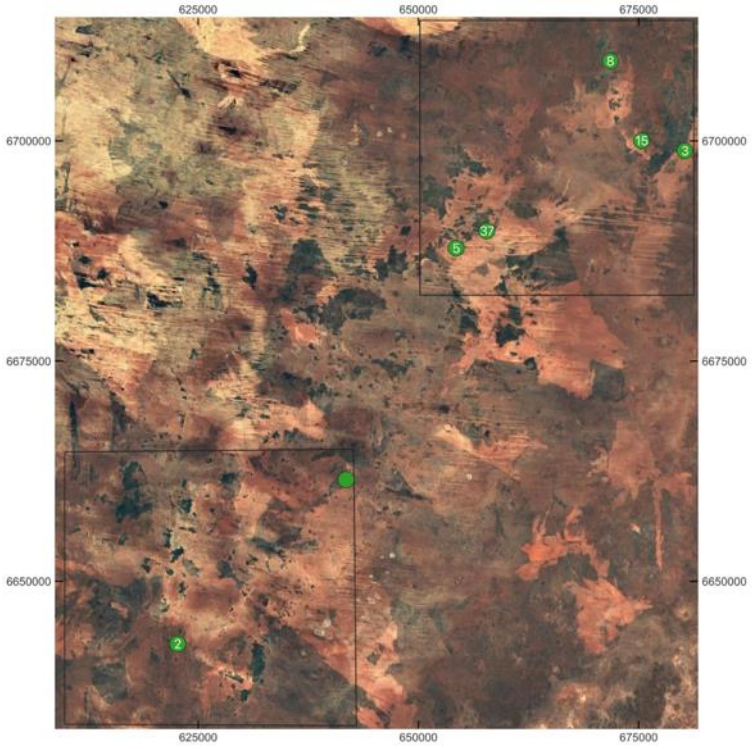

Figure 23 Spinifex Hopping Mouse in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.

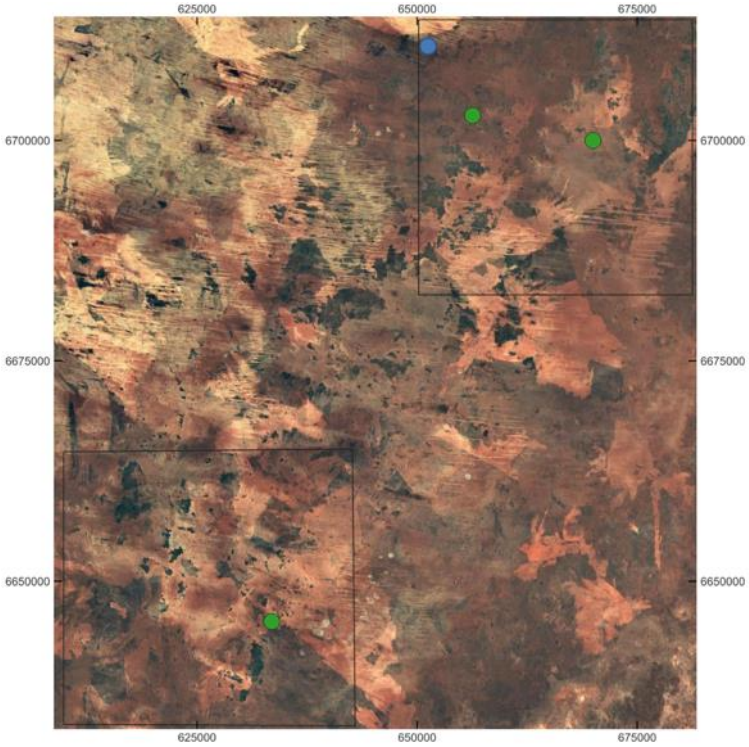

Figure 24 Echidna in the reference area (upper right box) and the management area (lower left box). Blue points depict cameras on-track and green points, off-track, with the values representing the number of independent detections. Points with no value represent a single detection.