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C2CD OFFSET PEST ANIMAL CONTROL SURVEY YEAR 3 REPORT

June 2024

DEPARTMENT OF TRANSPORT AND MAIN ROADS

Executive summary

Ecosure monitored vertebrate pests across 13 properties designated to offset the impact of the Bruce Highway Project: Cooroy to Curra Section D (C2CD) (Woondum to Curra) in Gympie. This is the third annual monitoring round following baseline monitoring February – April 2021. The offset properties are located in three main clusters: Curra, Victory Heights, and Woondum. Monitoring aimed to estimate Year 3 levels of pest activity in each offset cluster for comparison to the activity observed in 2021 (baseline), 2022 (Year 1) and 2023 (Year 2), as a means of measuring the efficacy of pest management activities.

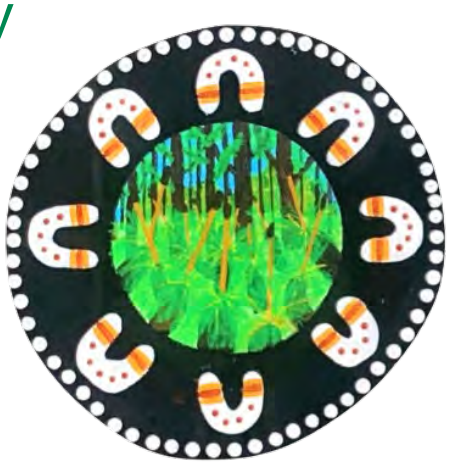
Camera traps were deployed mid-February across 68 sites for a total of 65 days. Activity indices for pest species in each offset cluster were estimated. Activity indices represent the expected number of detections (red fox, dingo/wild dog [herein referred to as wild dog, as dingo/wild dog distinction is not generally possible without genetic analysis], feral cat, feral pig) per camera station per day at each offset cluster; it is assumed that these indices are proportional to absolute pest abundance.

Red fox and feral pig activity continued to decline or remain stable in 2024 at all sites that they had previously been recorded at, with red foxes not being detected at Victory Heights, the site with the highest activity in previous survey periods. Feral cat activity remained consistently low at Curra and there were no detections at Victory Heights or Woondum. Wild dog activity increased at Curra and decreased marginally, remaining relatively high at Woondum. Observed activity is assumed to have been due to immigration from surrounding properties as several packs of dogs not identified in previous surveys (during the year, or in previous years) were detected at Curra.

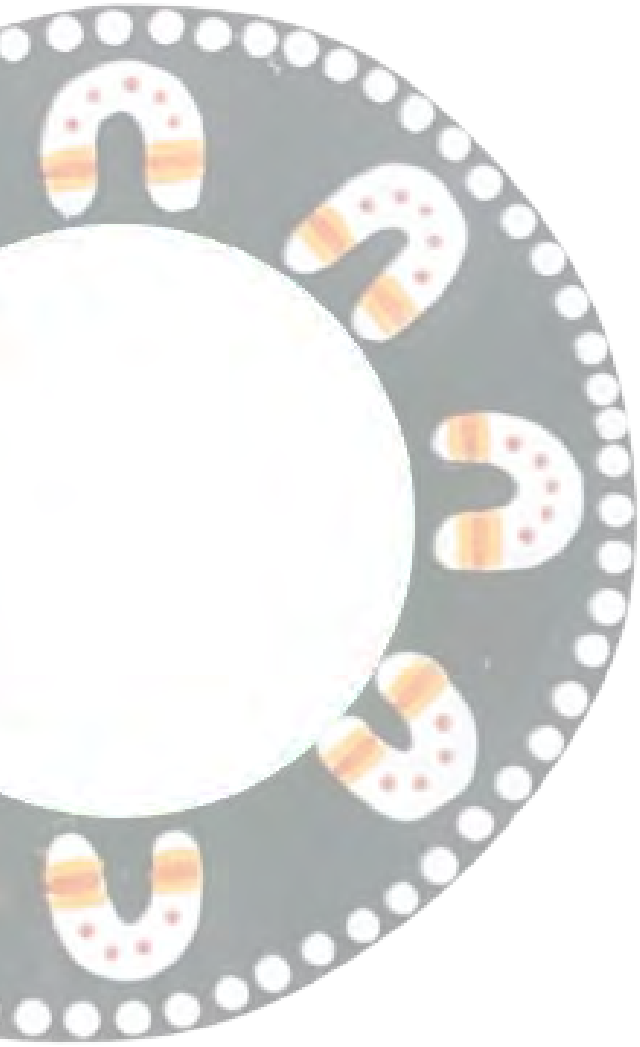
The results from the 2024 monitoring indicates that pest activity has decreased or remained consistent across the offset clusters, with the exception of wild dogs in Curra which has increased since the 2023 monitoring period. The results suggest current pest management efforts are effective in reducing pest activity within the offset clusters and that management should be maintained to mitigate natural fluctuations in local pest animal populations. Evidence suggests dingoes likely act to reduce impacts of cats and foxes on native species. Understanding the composition of these populations in the local area will inform management approaches in the future. Ecosure is currently conducting a trial for DNA collection from live individuals to confirm the purity of dingo DNA present in local populations.

Ongoing management should prioritise pest species with the highest activity indices, species displaying a substantial increase in activity and pest species that have not shown significant decline in activity. Feral cat and red fox activity has declined or remained stable at all sites that have recorded them previously; feral cats were not recorded at Victory Heights in 2024. Wild dog activity has increased since baseline monitoring, primarily at Curra but an increase in activity was also detected at Woondum in 2023 and remaining stable in 2024. Feral pigs continue to show a steady decline in activity at Curra.

Acknowledgement of Country



Ecosure acknowledge the Traditional Custodians of the lands and waters where we work. We pay deep respect to Elders past and present who hold the Songlines and Dreaming of this Country. We honour and support the continuation of educational, cultural and spiritual customs of First Nations peoples.



Acronyms and abbreviations

BBBQ	Black-breasted button-quail (*Turnix melanogaster*)
C2CD	Cooroy to Curra Section D
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GLMM	Generalised Linear Mixed Model
OMP	Offset Management Plan Detailed Design for the Cooroy to Curra Section D
the Project	Bruce Highway Project: Cooroy to Curra Section D (Woondum to Curra)
TMR	Department of Transport and Main Roads
Wild dog	*Canis lupus familiaris*. For the purpose of reporting and given the inability to distinguish genetic purity without DNA sampling, the term wild dogs also encompasses potential dingoes (*Canis lupus dingo)*

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1 Introduction

Ecosure monitored vertebrate pests on behalf of the Department of Transport and Main Roads (TMR) across properties designated to offset the impact of the Bruce Highway Project: Cooroy to Curra Section D (C2CD) (Woondum to Curra) (the Project). As part of the conditions of approval (EPBC 2017/7941) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), an Offset Management Plan (OMP) was developed by TMR. This included securing and managing 13 offset properties in the Gympie Region, located in Curra, Victory Heights, and Woondum, for koala (*Phascolarctos cinereus*) and black-breasted button-quail (*Turnix melanogaster*, BBBQ) (Table 1). The OMP outlined several conditions related to the delivery of offsets, including pest management.

Ecosure was engaged by TMR to undertake quarterly pest control works (commencing October 2021) within the offset properties, as described in the detailed OMP, targeting pest species known to threaten koala and BBBQ: red fox (*Vulpes vulpes*), wild dog (*Canis lupus familiaris*), feral pig (*Sus scrofa*), and feral cat (*Felis catus*). In order to assess the efficacy of pest management works over 10 years, Ecosure developed the Pest Animal Monitoring Program (Ecosure 2020) to detect pest activity level changes and allow implementation of the active Control Plan (Ecosure 2021) to be evaluated. Baseline pest animal monitoring was conducted across the offset properties in early 2021, in accordance with the Pest Animal Monitoring Program. This established a baseline activity index for each relevant pest species in each offset cluster.

In early 2024, Ecosure commenced the fourth round of offset pest monitoring, representing Year 3 of the Pest Animal Monitoring Program (i.e. following baseline monitoring). This report provides an overview of methodology and results from Year 3 monitoring (February – April 2024). It also provides a discussion on pest activity levels in comparison to observations recorded during the baseline (2021), Year 2 (2022) and Year 3 (2023) monitoring periods.

1.1 Scope of works

The scope of the monitoring program included:

- monitoring as per the Pest Animal Monitoring Program (Ecosure 2020):
  - minimum eight-week camera monitoring period
  - 68 cameras deployed across three offset clusters in Gympie (Curra, Victory Heights, Woondum)
  - regular battery and SD card checks.
- analysing camera trap images and conducting statistical analyses
- preparing the Year 3 monitoring report summarising field and statistical methods, results, and supporting maps.

Control works are also undertaken in accordance with the Pest Control Plan (Ecosure 2021). Results of the control program are reported in monthly progress reports and summarised in Section 3.2.

1.2 Site context

Of the three offset clusters, Curra is the largest (approximately 239 ha), followed by Woondum (56 ha) and Victory Heights (46 ha); the total offset area is around 341 ha (Table 1, Figure 1).

Table 1 Offset site details

Cluster location/name	Lot/Plan	Offset focal species	Area (ha)	Total area (ha)
Curra	1MPH23906	koala	27.69	239.44
	3MPH23906	koala	22.97	
	4MPH23906	koala	3.46	
	878MCH1061	koala	144.56	
	889CP864404	koala	40.77	
Victory Heights	19SP299683	koala	26.86	45.58
	1MPH23904	koala	5.85	
	1MPH5670	koala	2.02	
	2MPH14193	koala	7.27	
	763MCH5342	koala	3.58	
Woondum	102SP297908	koala + BBBQ	12.66	56.09
	2SP302526	koala + BBBQ	15.18	
	3SP302524	koala + BBBQ	28.25	
Total				**341.11**

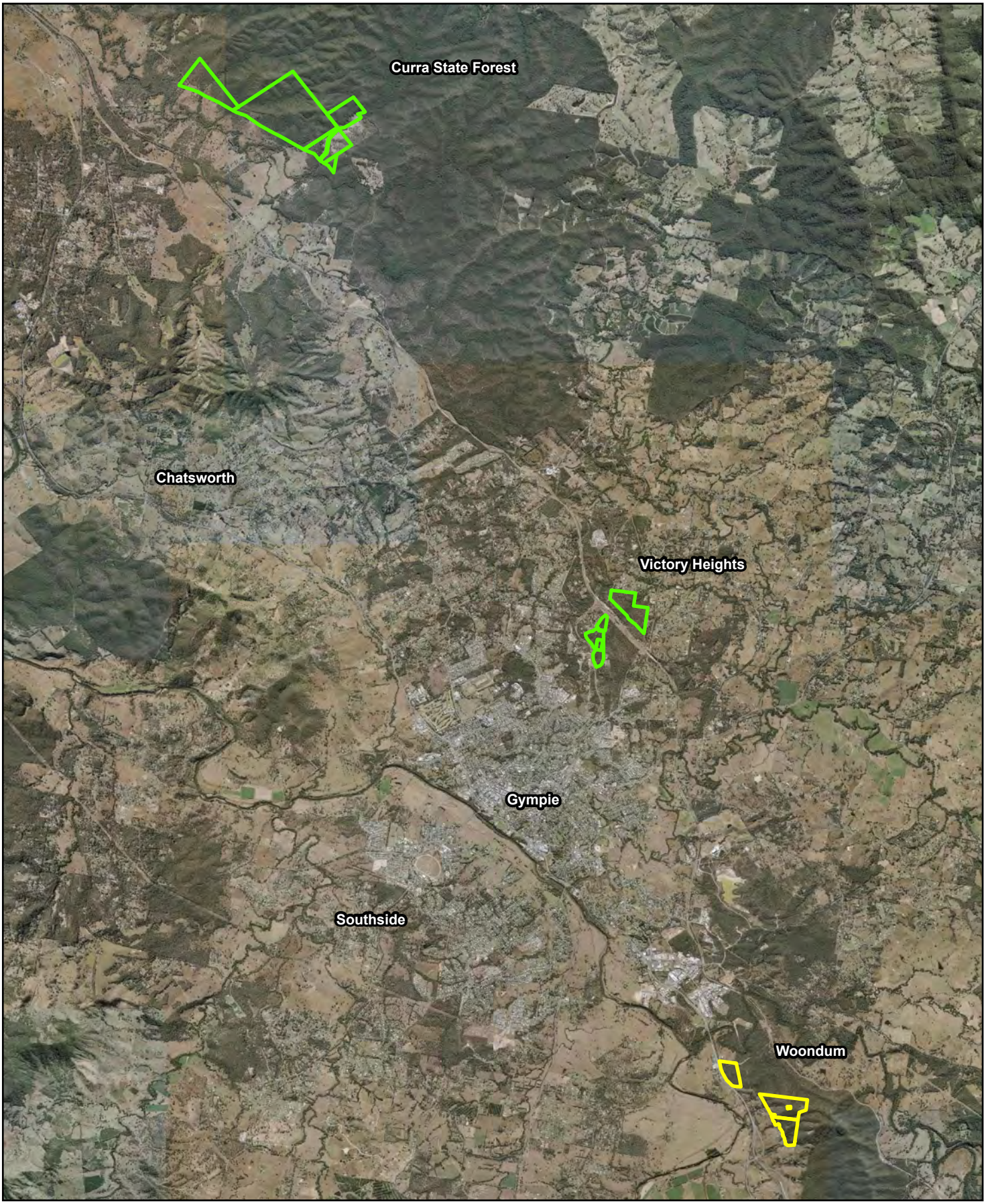

Figure 1: Location of the Bruce Highway Project: Cooroy to Curra Section D (Woondum to Curra) offset sites

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C2CD Offset Pest Animal Control and Survey - Year 3

Offset area

- Koala
- Koala + Black-breasted button quail

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Revision: 0
Author: TD
Date: 5/06/2024

0 0.5 1 2 3
Kilometers

GDA2020
Datum: GDA2020
Units: Degree

PR6714_MP1_offset_sites
A4

2 Methods

The following field work, analysis and reporting was undertaken by suitably qualified personnel to meet the Commonwealth Requirements of the OMP. See Appendix 1 for further details on personnel and their roles throughout this project.

2.1 Camera trapping

Sixty-eight passive infrared cameras (Reconyx Professional HP2X Hyperfire 2, Reconyx Inc. Holmen, WI, USA; Scoutguard BolyGuard Trail Camera, Scoutguard Australia[1]) were deployed on the 12th and 13th February 2024 and collected on the 16th and 17th April 2024. Cameras were installed to the same specifications as baseline monitoring (Ecosure 2021), including location (same tree where possible), direction, height, and angle, in order to maintain consistent detectability between different monitoring periods (see Appendix 2 for camera locations). In some cases, this was not possible, though only small adjustments were made to ensure minimal changes to detectability (Table 2). Additionally, three cameras (5, 59 and 68) were damaged during deployment and failed to record for the entire period, reduced sampling is not anticipated to impact the robusticity of this reports results.

Table 2 Camera location adjustment details.

Camera	Distance moved	Reason
20	40 m	Lantana regrowth limited access to 2023 location, a suitable nearby tree was chosen
46	30 m	Lantana regrowth limited access to 2023 location, a suitable nearby tree was chosen
50	5 m	2023 tree had fallen, a suitable nearby tree was chosen
55	2 m	Unable to locate 2023 tree, a suitable nearby tree was chosen
56	20 m	Lantana regrowth limited access to 2023 location, a suitable nearby tree was chosen
57	2 m	Unable to locate 2023 tree, a suitable nearby tree was chosen

In accordance with baseline monitoring, cameras were placed approximately 250 m apart along roads, tracks, and movement corridors where possible, or suitable nearby locations. Cameras were attached to stable, permanent tree trunks approximately 30 cm from the road/track edge (where applicable), 50 cm above the ground, approximately 45° to the road/track, and north/south-facing to avoid direct sunlight. Vegetation in front of the cameras was trimmed to reduce the number of false triggers and maximise pest animal detectability. Cameras were set to capture images with the following settings: rapid fire, no delay, 10 images per trigger, 3.1-megapixel resolution, high sensitivity, night mode: fast shutter or high quality.

To maximise the detection of feral cats in Woondum offset sites, seven camera traps were baited with tinned cat food.

[1] Scoutguard and BolyGuard cameras were used in areas where cameras have been historically stolen/vandalised.

2.2 Data analysis

2.2.1 Image sorting

Camera trap images were analysed over the two-weeks following camera collection. A five-minute window was used to discriminate between independent pest observations i.e. an observation was considered independent if it was separate from the preceding image/s by more than five minutes. In instances where animal behaviour clearly negate this, e.g. animals resting near cameras for extended periods, a single observation was scored. This ensured that calculating the activity index based on this rule would not introduce inaccuracies that may inflate true activity. As such, image sequences were analysed to individually identify pest species where possible. When clusters of images occurred suggestive of the same individual(s) they were only classed as independent if they were separated by approximately 30 minutes spent away from the camera.

All observations were entered into a database with the corresponding camera number, offset cluster, track type, and bait status used for statistical analyses.

2.2.2 Statistical analyses

An activity index was used to represent relative pest abundance in each offset cluster due to the challenges of deriving an absolute species population abundance within offset clusters (Bengsen et al. 2014; Thompson et al. 2019). The activity index describes the expected number of detections (red fox/wild dog/feral cat/feral pig) per camera station per day at each offset cluster.

Activity indices were calculated using maximum likelihood (Laplace Approximation) generalised linear mixed models (GLMMs) fit by a negative binomial error distribution. This differs to previous years where normal or Poisson distributions were employed. Though the Poisson error distribution provided the best fit (of the models available in 2021) for baseline data, the data are heavily clustered (i.e. many observations at a small number of cameras) and occasionally failed to produce consistently sensical results (i.e. negative activity indices), meaning the activity indices may not represent the raw data well. Normal error distributions were used during analysis of Years 1 and 2 of monitoring, normal error distribution technically provide a poorer fit for the model but ensured that the parameter point estimates (i.e. activity indices) better represent the raw data. As of 2024, negative binomial distributions were made available in the current model package and provide a much better fit for heavily clustered data. As with previous reports, sequential analysis of annual datasets was conducted. The addition of negative binomial distribution in 2024 also improves the accuracy of indices calculated for previous years. As such some indices are now incongruent with results published in previous reports, given the comparative robusticity of the analysis conducted in this report, the results provided should be taken to supersede those in previous reports. The R Studio coding scripts for each activity index calculation are provided in Appendix 3.

2.3 Limitations

Limitations pertinent to the survey design are outlined in the Pest Animal Monitoring Program (Ecosure 2020).

Deployment of cameras for baseline monitoring was originally scheduled for November 2020 but unavoidable delays outside Ecosure control resulted with commencement in February 2021. Ideally, monitoring would have been in late-spring/early-summer to coincide with peak activity of foxes and wild dogs. However, red foxes and wild dogs continue to disperse until

late May (DAF 2016), so this monitoring period was deemed acceptable for baseline monitoring. While this has the potential to reduce species detectability compared to potentially higher activity periods, if monitoring is conducted at the same time each year (as was the case in 2022, 2023 and 2024), robust comparisons in species abundance/activity trends can be made particularly given the application of more powerful statistical methods (detailed in Section 2.2.2) in 2024.

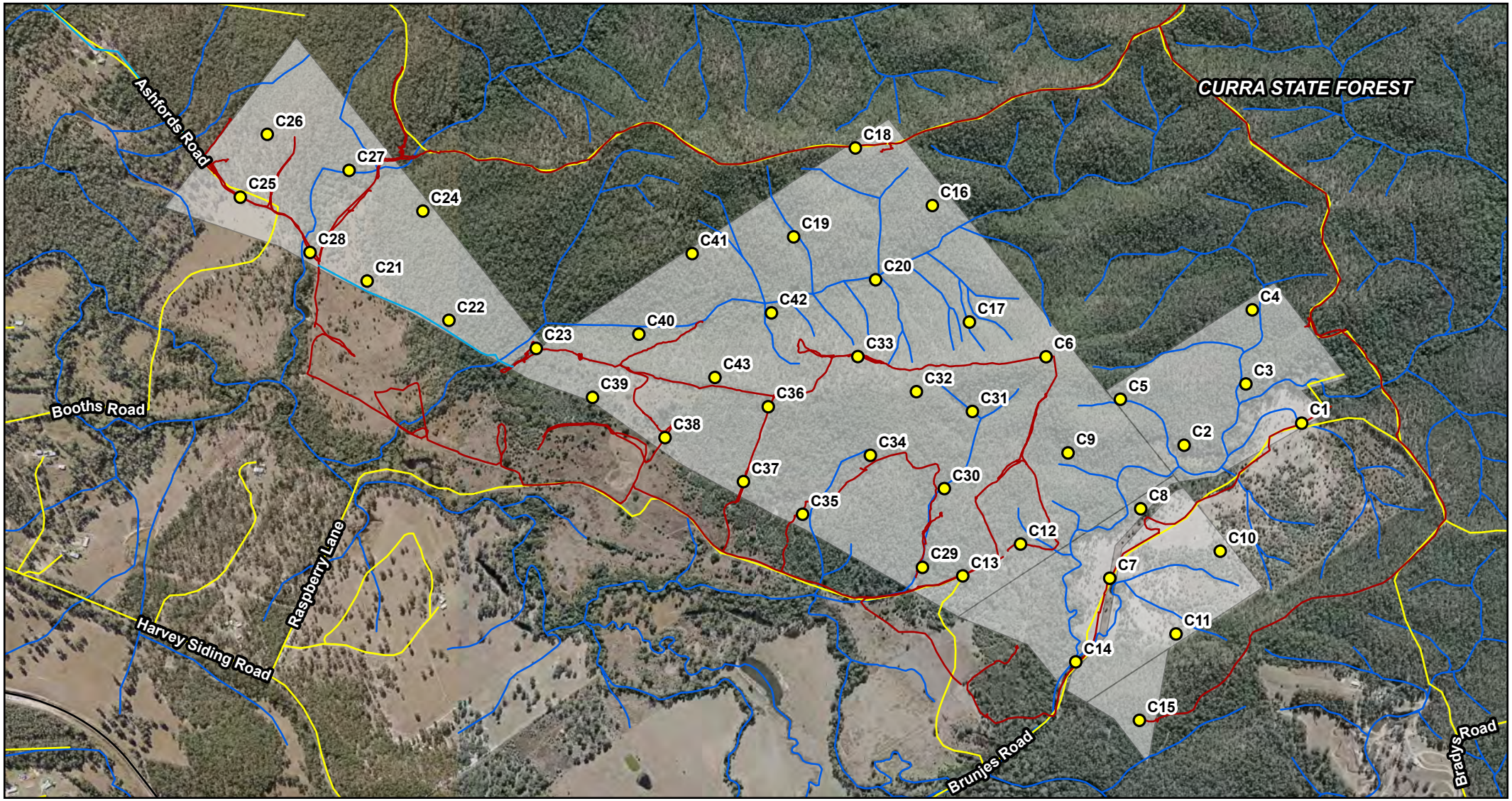

Figure 2: Camera locations in Curra offset sites

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C2CD Offset Pest Animal Control and Survey - Year 3

Camera location
Watercourse
Tracks/roads
Existing access track
Proposed access track
Road
Rail network
Curra offset area

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Job number: PR6714
Revision: 0
Author: TD
Date: 5/06/2024

0 175 350 700
Metres

GDA2020
Datum: GDA2020
Units: Degree

PR6714_MPX_Curra_camera_locations
A4

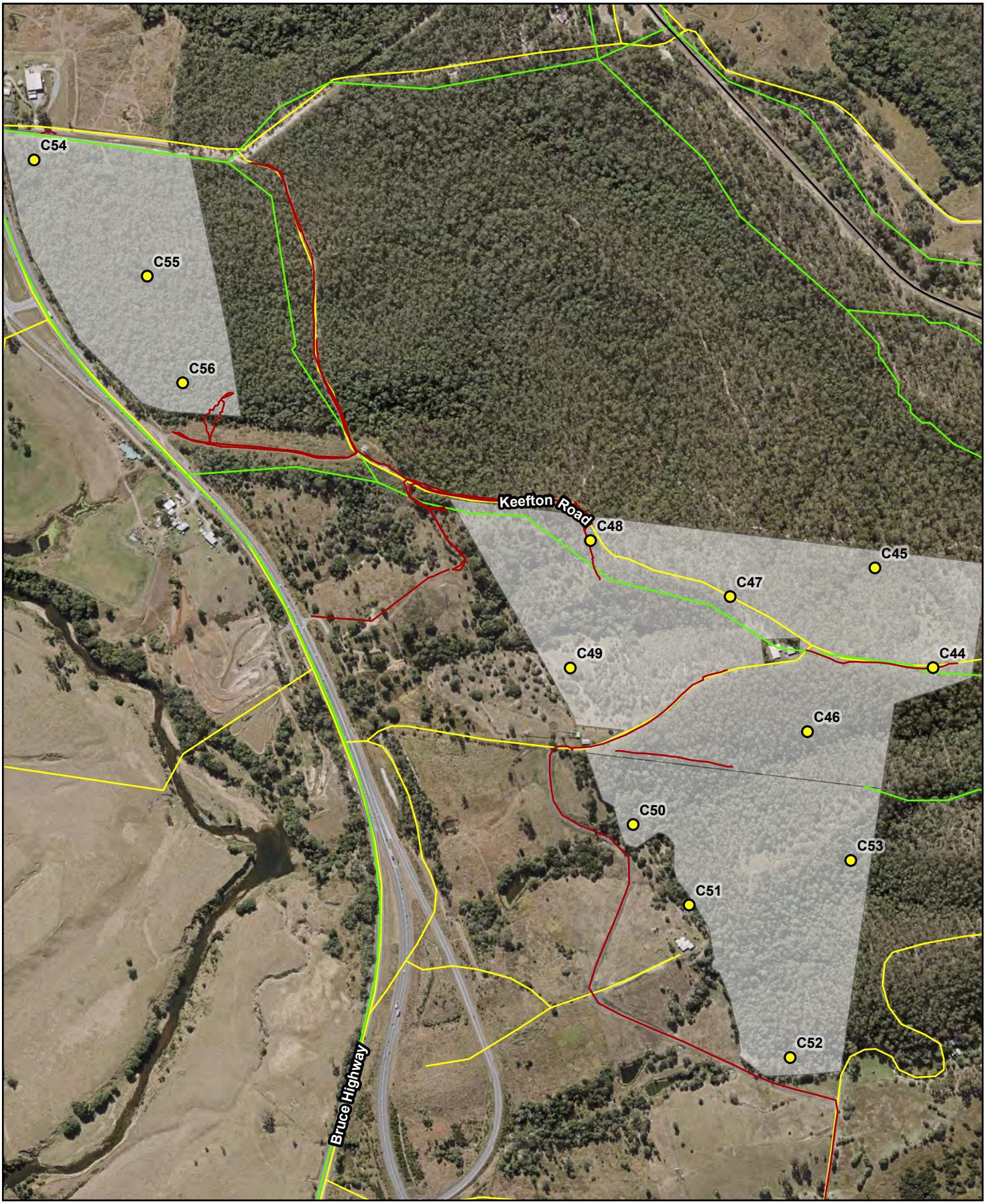

Figure 3: Camera locations in Woondum offset sites

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C2CD Offset Pest Animal Control and Survey - Year 3

Camera location
Watercourse
Tracks/roads
Existing access track
Rail network
QPWS access road
Road
Woondum offset area

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Job number: PR6714
Revision: 0
Author: TD
Date: 5/06/2024

0 50 100 200
Meters

GDA2020
Datum: GDA2020
Units: Degree

PR6714_MPX_Woondum_camera_locations
A4

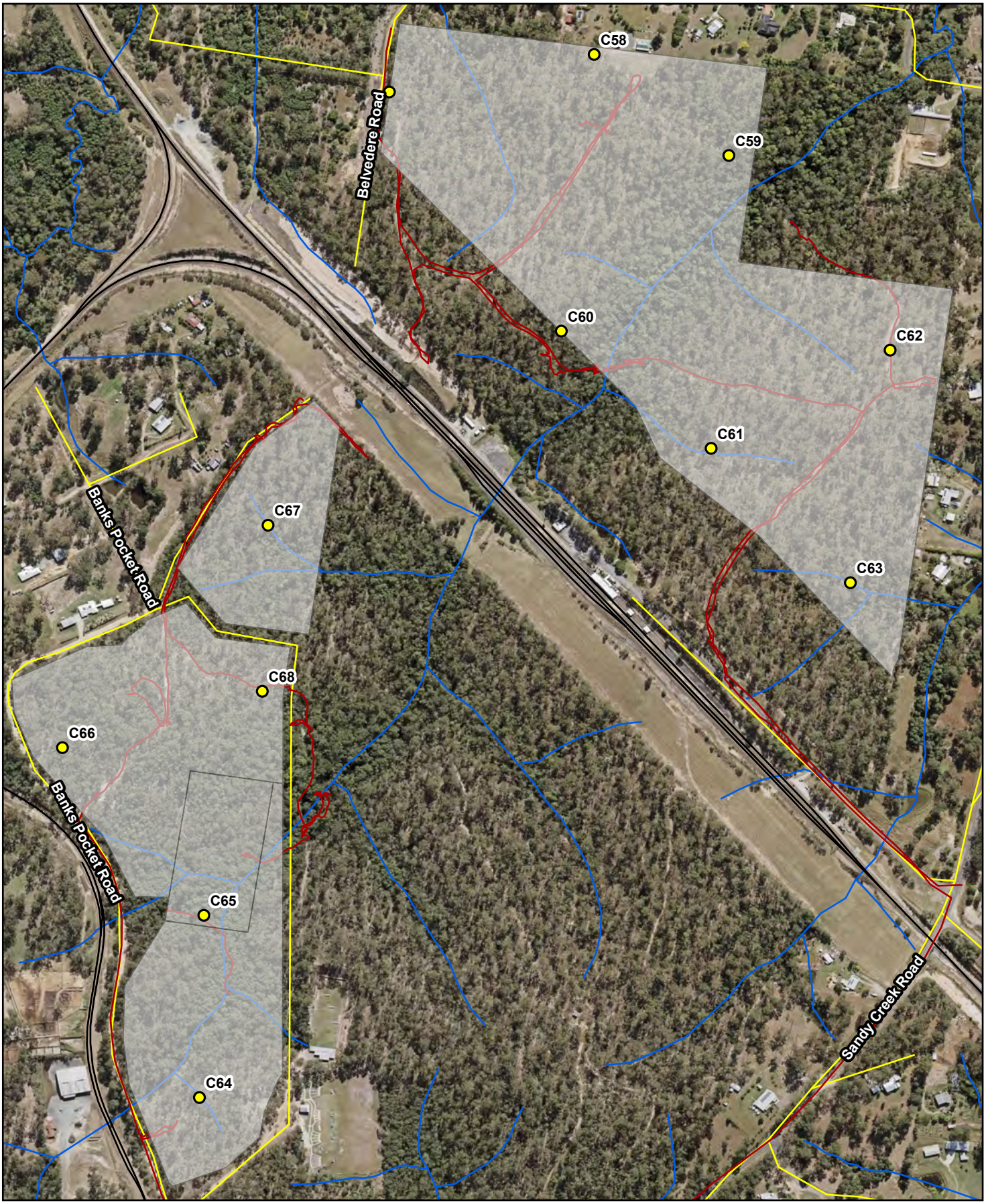

Figure 4: Camera locations in Victory Heights offset sites

Department of Transport and Main Roads

C2CD Offset Pest Animal Control and Survey - Year 3

Camera location

Tracks/roads

- Existing access track
- Rail network
- Road
- Watercourse
- Victory Heights offset area

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Job number: PR6714
Revision: 0
Author: TD
Date: 5/06/2024

0 50 100 200
Meters

GDA2020
Datum: GDA2020
Units: Degree

PR6714_MPX_VictoryHeights_camera_locations
A4

3 Results

3.1 Pest species detection trends

Red foxes were recorded in Curra and Woondum but were absent at Victory Heights (Table 3). This differs from previous years during which red foxes were recorded at all sites with the highest activity detected in Woondum followed closely by Curra. Analysis indicates that Victory Heights has historically had the highest red fox activity however activity has consistently declined since baseline monitoring in 2021. With the exception of Woondum between 2022 and 2023, red fox activity has declined (due to control; Section 3.2) or remained stable at every offset cluster every year with 2024 either lower than or comparable to the lowest recorded activity from any previous year at a given site.

Wild dogs were detected at Curra and Woondum. Dogs detected at Victory Heights were domestic dogs with collars so are excluded from the dataset. This is consistent with baseline results (Table 3) in which dogs have only been recorded in Woondum and Curra. Analysis indicates that wild dog activity has increased at Curra, which saw activity indices rise from 0.00123 (the lowest recorded to date) to 0.008027. Although this represents an increase, it is still lower than what was recorded during the baseline and 2022 collection periods. Activity at Woondum decreased marginally but remains relatively high.

Feral cats were only detected at Curra with low activity (Table 3, Figure 5). Analyses suggests that feral cat activity has decreased in 2024 but has remained broadly consistent with the overall low activity identified throughout the Project (Figure 5). Given the low total detections of feral cats (five detections in 2024) comparing activity indices can be problematic and potentially driven by data stochasticity rather than being reflective of genuine trends.

Feral pigs were only recorded in Curra, which is consistent with past monitoring periods (Table 3, Figure 5). During previous monitoring, feral pigs were only occasionally detected in Curra, though the sporadic nature of detections and high variability of group sizes (1 – 20 individuals) across the monitoring periods means that the data are limited. Feral pig activity continued to decline and is now lower than any point since baseline monitoring.

The spatial distribution of pest animal activity within each offset cluster is shown in Figures 6-8. Note, these maps show total number of pest observations on each camera in 2024.

Additionally, one koala (Appendix 4) was detected in Woondum (Camera 45) during the 2024 monitoring period.

Table 3 Activity indices calculated for each pest species in each offset cluster.

Offset cluster	Pest activity indices (estimated no. of observations/camera/day)															
	red fox				wild dog				feral cat				feral pig			
	2021	2022	2023	2024	2021	2022	2023	2024	2021	2022	2023	2024	2021	2022	2023	2024
Curra	0.015	0.00518	0.00111	0.00143	0.00842	0.01283	0.00123	0.0081	0.001152	0.00229	0.00031957	0.000011333	0.000169	0.002313	0.001642	0.000017106
Woondum	0.0115	0.01846	0.00111	0.00147	0.00261	0.00287	0.011987	0.00976	0.000349	0	0	0	0	0	0	0
Victory Heights	0.0424	0.03117	0.00375	0	0	0	0	0	0.00091	0.00316	0	0	0	0	0	0

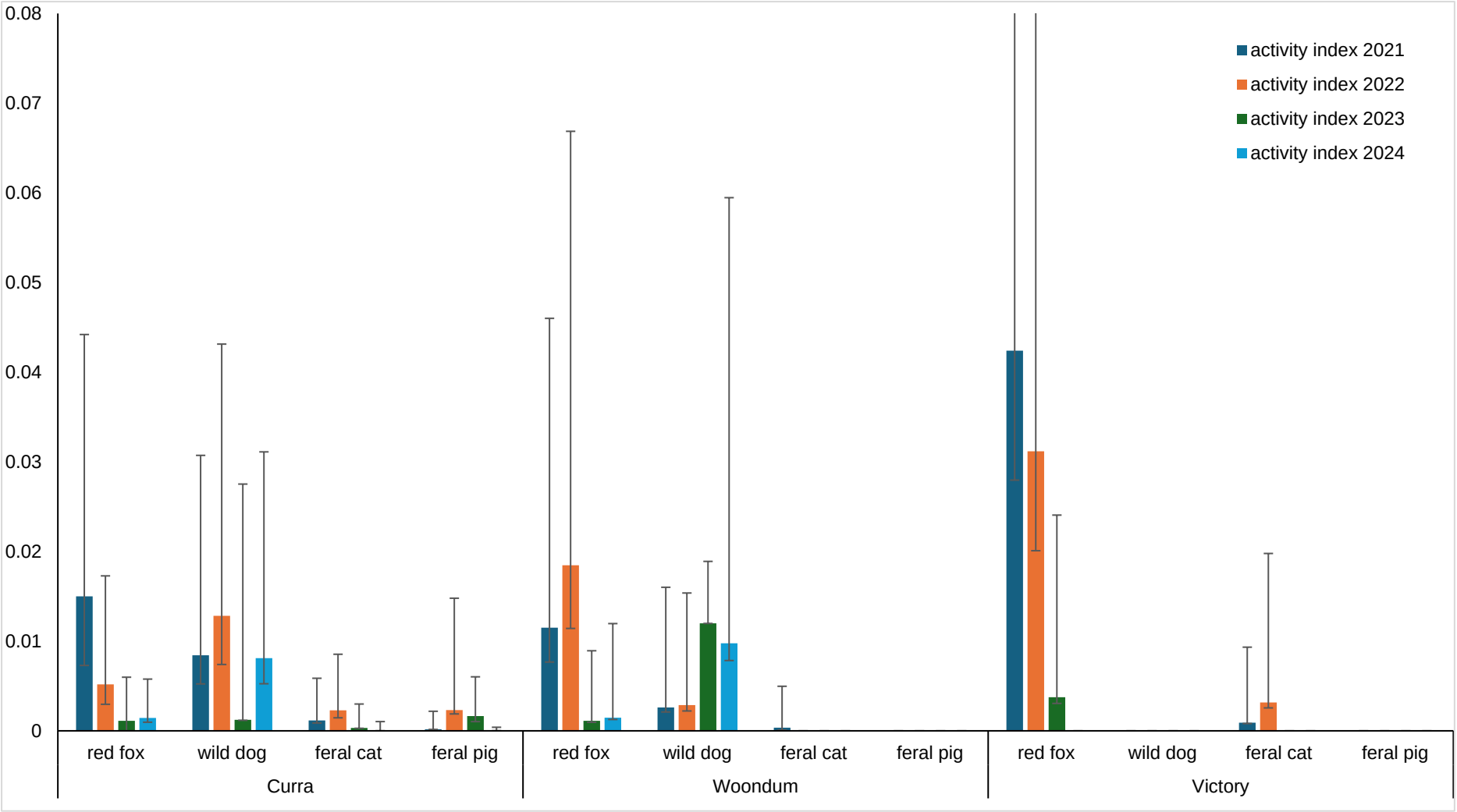

Figure 5 Pest activity indices estimated from camera traps deployed in February 2024. GLMM were used to calculate the activity index. The index estimates the number of observations of each pest species per camera per day. The data are presented with standard error bars showing confidence intervals, however as some error bars are quite large a smaller data frame has been provided to allow for easier interpretation of key trends, raw data (including upper CIs) provided in Appendix 5.

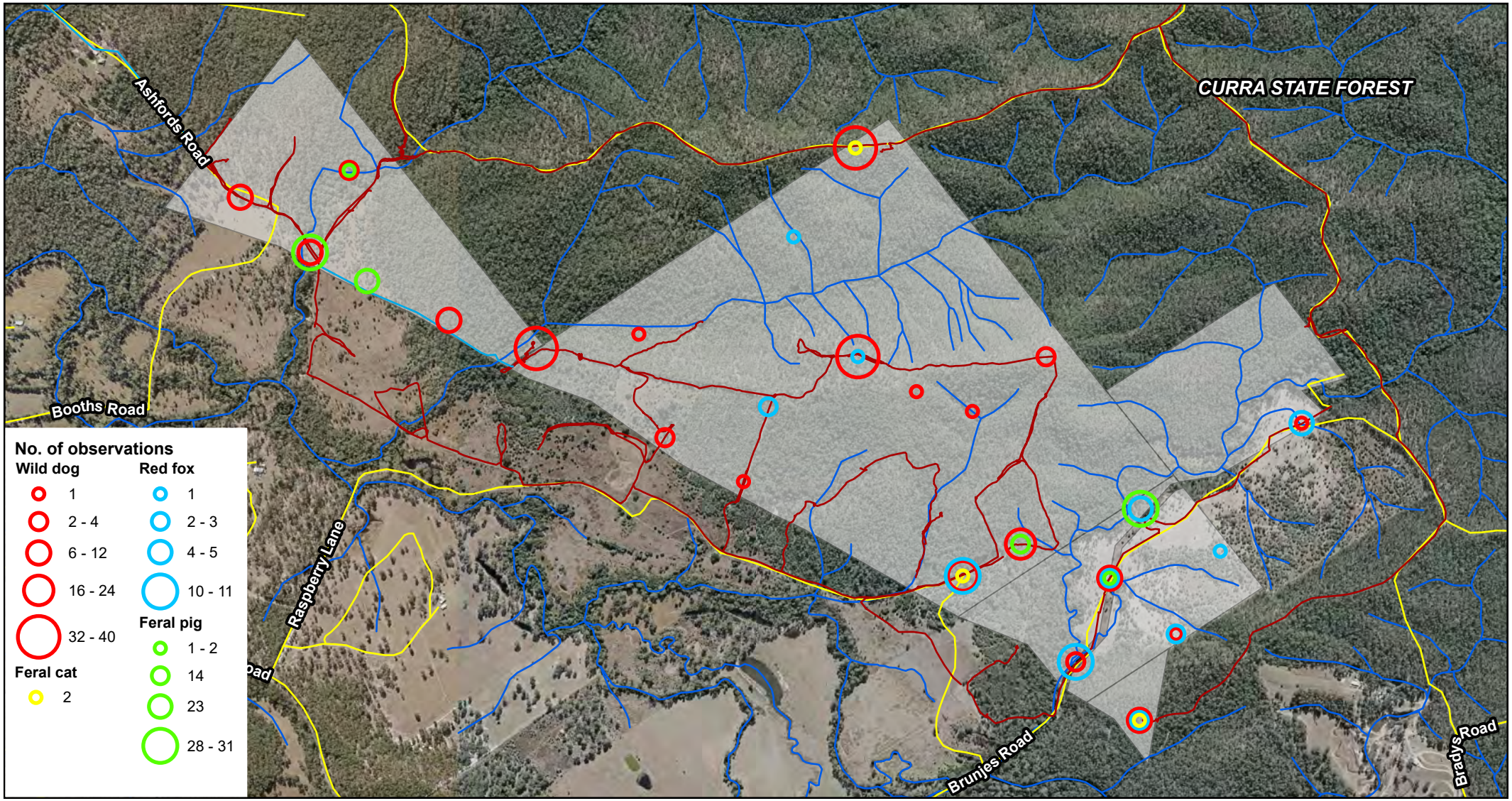

Figure 6: Pest animal observations in Curra offset properties

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C2CD Offset Pest Animal Control and Survey - Year 3

Watercourse
Road
Tracks/roads
Rail network
Existing access track
Curra offset area
Proposed access track

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Date: 7/06/2024

0 175 350 700
Metres

GDA2020
Datum: GDA2020
Units: Degree

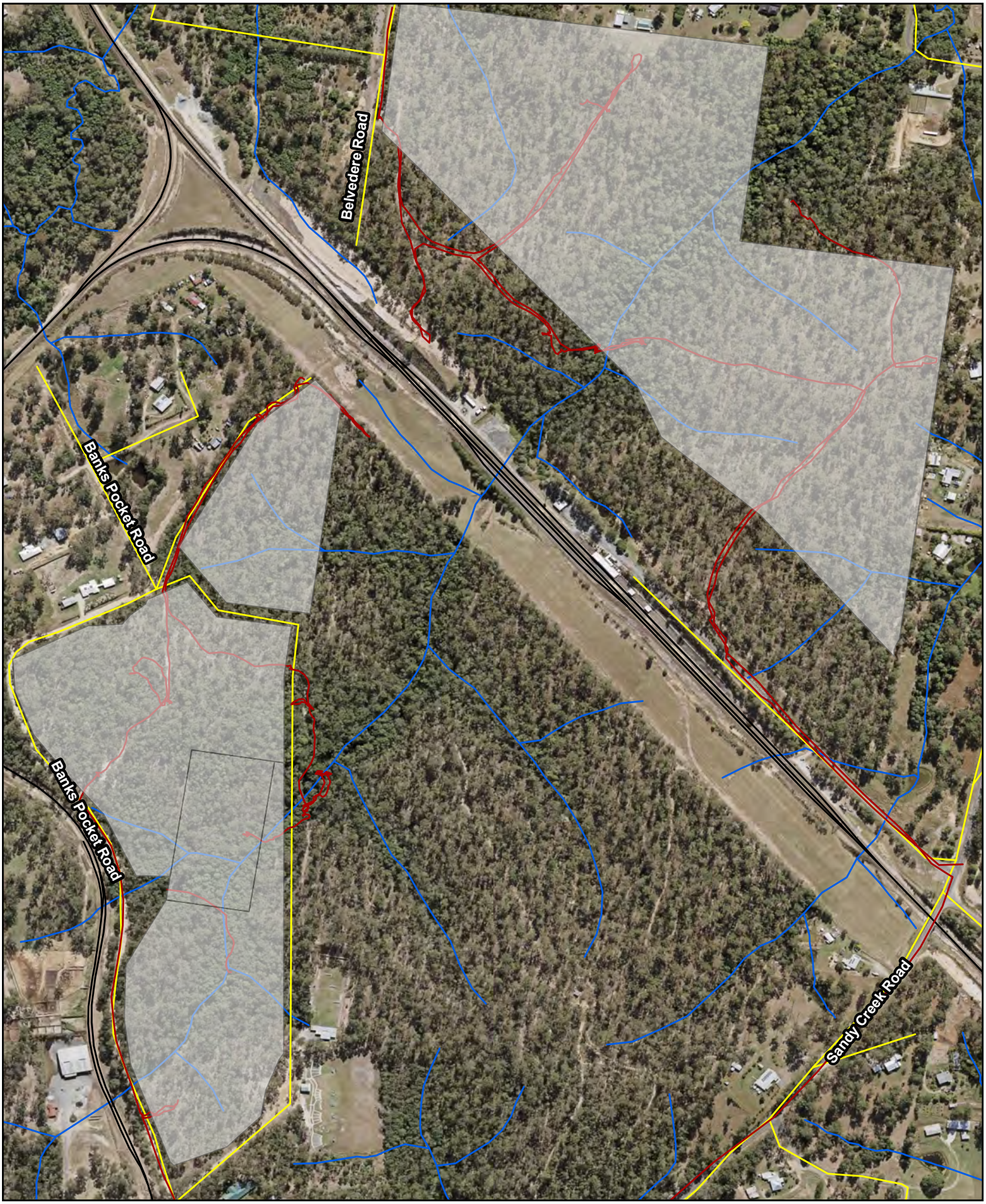

Figure 7: Pest animal observations in Victory Heights offset properties

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C2CD Offset Pest Animal Control and Survey - Year 3

Tracks/roads

- Existing access track
- Rail network
- Road
- Watercourse
- Victory Heights offset area

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Job number: PR6714
Revision: 0
Author: TD
Date: 11/06/2024

0 50 100 200
Meters

GDA2020
Datum: GDA2020
Units: Degree

PR6714_MPX_VictoryHeights_pest_activity
A4

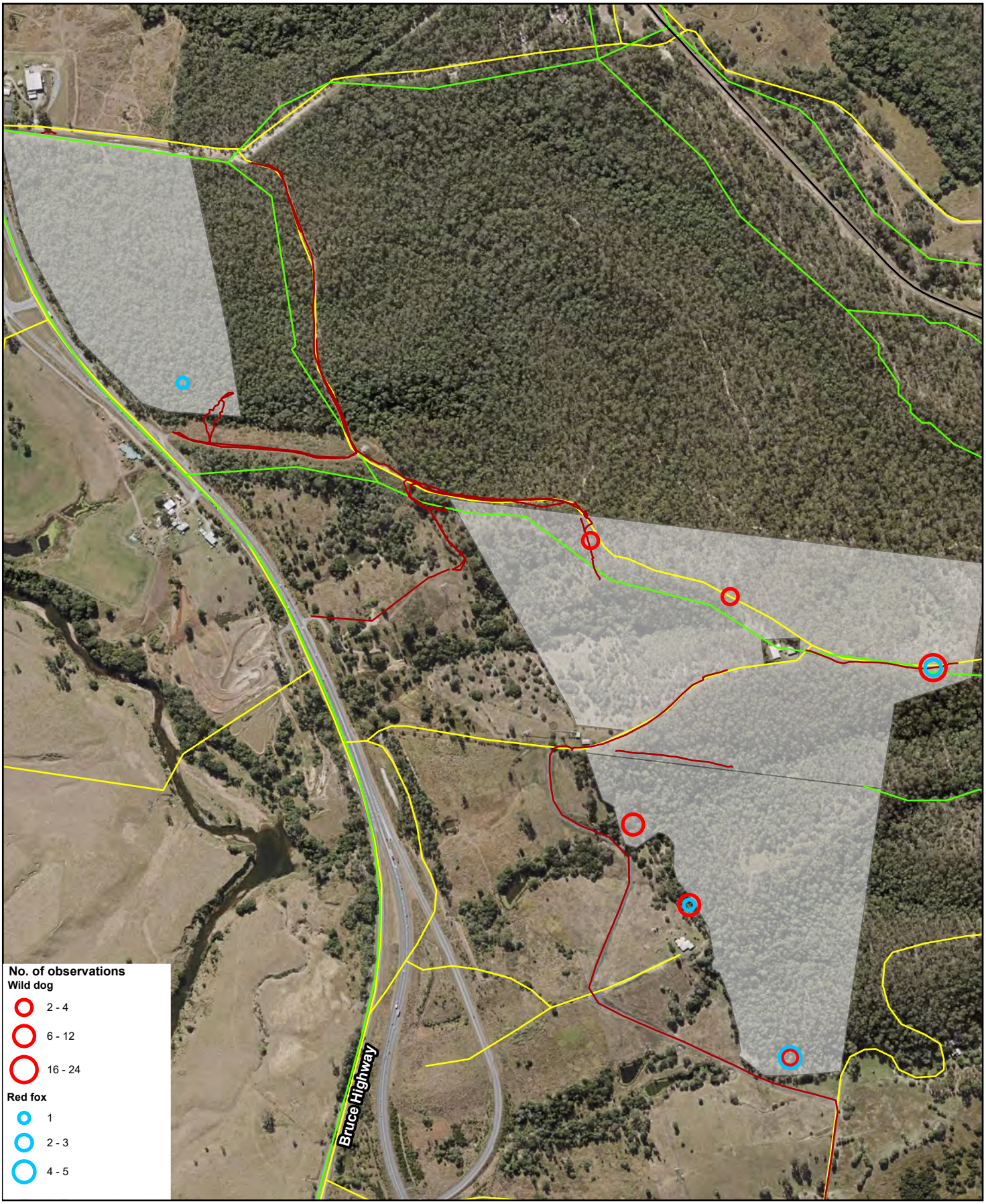

Figure 8: Pest animal observations in Woondum offset sites

Department of Transport and Main Roads

C2CD Offset Pest Animal Control and Survey - Year 3

Tracks/roads

- Existing access track
- Rail network
- QPWS access road
- Road

Woondum offset area

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Job number: PR6714
Revision: 0
Author: TD
Date: 7/06/2024

0 50 100 200
Meters

GDA2020
Datum: GDA2020
Units: Degree

PR6714_MPX_Woondum_pest_activity
A4

3.2 Summary of pest control works

Control program results are detailed in monthly reports with an overall summary to date in Table 4.

Camera monitoring during control periods showed limited red fox, feral cat and wild dog presence. The pack of wild dog/dingoes at Curra was not seen during control periods prior to annual monitoring and only over several days towards the end of this monitoring period. This suggests it is a pack dispersing/moving through the landscape and demonstrates how significantly monitoring results can be influenced by uncommon, landscape-scale movements beyond the boundaries of the offset properties. The number of animals removed during control, as shown in Table 4, should be used as a success measure when interpreting monitoring results.

Table 4 Summary of pest animals humanely euthanased before and after monitoring periods

Offset cluster	Period	Species							
		red fox		wild dog		feral cat		feral pig	
		Before	After	Before	After	Before	After	Before	After
Curra	Baseline *1	0	0	0	0	0	0	0	0
	Year 1 *2	0	2	0	5	0	0	8	15
	Year 2 *3	1	1	1	0	0	0	2	1
	Year 3 *4	1	0	0	0	0	0	6	0
Victory Heights	Baseline	0	0	0	0	0	0	0	0
	Year 1	0	0	0	0	0	0	0	0
	Year 2	0	0	0	0	0	0	0	0
	Year 3	1	0	0	0	0	0	0	0
Woondum	Baseline	0	0	0	0	0	0	0	0
	Year 1	0	2	0	0	0	0	0	0
	Year 2	0	0	0	0	0	0	0	0
	Year 3	2	0	1	0	0	0	0	0
Year 3 Total		4	0	1	0	0	0	6	0
Grand Total to Date		10		7		0		32	

*1 Baseline monitoring. Before = before baseline monitoring (i.e. before February 2021); After = after baseline monitoring (i.e. April 2021 – October 2021).
*2 Year 1. Before = before Year 1 monitoring (i.e. October 2021 – January 2022); After = after Year 1 monitoring (i.e. April-October 2022).
*3 Year 2 monitoring. Before = before Year 2 monitoring (i.e. October 2022 – January 2023); After = after year 2 monitoring (i.e. April-June 2023)
*4 Year 3 monitoring. Before = before Year 3 monitoring (i.e. July 2023 – January 2024); After = after year 2 monitoring (i.e. Febuary 2024 - present)

4 Discussion & recommendations

Results from the 2024 monitoring event suggest relatively low pest activity at all offset sites with the exception of wild dogs at Curra which experienced an increase in recorded activity between 2023 and 2024. Feral pig and red fox activity at all sites has continued to decline or remain stable. Feral cat activity has remained low at Curra and has decreased every year, with the exception of 2021 to 2022. The observed changes in pest activity between years may be due to several factors, including (but not limited to):

- active pest management on the offset properties, and by surrounding landholders, reducing abundance of pests
- dingo activity potentially limiting foxes and feral cats - wild dog/dingo scat analysed from the Project area previously included feral cat remains (see Appendix 6), and mesopredator pressure on these other invasive species (see below)
- natural immigration and emigration of pest animals from the surrounding landscape
- sampling error resulting from limitations of camera trapping e.g. detections are opportunistic and may / may not reflect changes in target species behaviour rather than abundance.

The potential impact of each of these factors on the pest activity within each offset cluster cannot be determined without additional control sites (i.e. monitoring at sites with no management), which are beyond the scope of this program. It is likely that the reduction in pest activity is due to the ongoing control program with seven wild dogs, ten red foxes and 32 feral pigs removed from the landscape, and possibly a combination of these other factors.

The increase in wild dog activity at Curra and continuation of relatively high activity (compared to 2023) at Woondum is largely associated with selective culling of obvious hybrid dogs, with retention of animals with appearance of high purity while the live DNA trial is undertaken. As with previous years, several packs of dogs observed on camera traps appear to contain animals not identified in previous monitoring periods (Appendix 4), suggesting as expected that immigration from surrounding areas is an ongoing issue to ongoing reduction of this wide-ranging species (Ecosure 2023). The effect on activity indices of a single group of animals highlights the impact that natural animal movement within the broader landscape has on monitoring results. It also highlights the limitation of relying on activity indices alone when monitoring population dynamics without relevant context such as individual movement data or the maturity of the observed individuals. It is for this reason that, as recommended in previous reports, management success should be assessed within broader ecological and administrative context rather than activity indices which can be biased by local events or data stochasticity and reactive or short-term control actions.

A growing body of research is suggesting that wild dog populations are likely to express a high proportion of dingo ancestry (Cairns et al. 2021). This is also true for wild dogs in the Gympie region as Cairns et al. (2021) recovered purity rates of from 65% - 75% and >75% in local populations. Research also suggests that dingo presence likely acts to mitigate the impacts of other feral predators, particularly cats and foxes while predating small sensitive species at much lower rates than either cats or foxes (Glen et al. 2007 Brook et al. 2012, Gordon et al. 2015). DNA collection from live wild dogs/dingoes will inform future management at the site.

The lowest response in activity indices given control efforts continues to be feral cats in Curra. Efforts should be maintained or increased in Curra for all species, particularly wild dogs given the increase in recorded activity in 2024. While wild dog activity is similar at Curra and Woondum, the total population at Curra is likely much higher given the size, connectivity and

resource availability. Additionally, as Curra is a larger, better-connected reserve likely experiencing lower impacts from anthropogenic disturbance (compared to Woondum or Victory Heights) the impact of feral pest animal control may provide more beneficial biodiversity outcomes than comparative works at Woondum or Victory Heights. Pest control should continue at all sites including ongoing review of additional/alternative control options that may be incorporated for future pest management activities.

References

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Appendix 1 Suitably qualified personnel

The following personnel were involved in the on-ground field work, statistical analyses, and reporting for this project.

Name & role	Qualifications	Relevant experience
Jess Bracks Principal Wildlife Biologist ***Project Manager, Reviewer***	Bachelor of Applied Science in Animal Studies (Wildlife Biology), University of Queensland, 2005	Jess is a Wildlife Biologist with 16 years' practical experience in the veterinary, zoo and consulting industries. She is passionate about driving pragmatic wildlife management policy; balancing the needs of community and conservation. Jess is often invited to advise on policy for local, state and federal government. Jess has played pivotal roles in facilitating various multi-stakeholder groups with a focus on coordinated and strategic wildlife management and pest animal management at regional and national levels. Jess has prepared numerous pest animal management plans and programs and is often involved in on-ground monitoring and management.
Andrew Bengsen Vertebrate Pest Specialist, NSW DPI ***Statistical analysis, reviewer***	PhD (Wildlife Biology), University of Queensland, 2010 Bachelor of Science (Honours) (Zoology and Tropical Ecology), James Cook University, 2003	Andrew has over 16 years' experience in pest animal management and research and has been with the Vertebrate Pest Research Unit since 2011. Most of his current research aims to improve the management of introduced large herbivores by understanding the effects of different management tools, strategies and policies on herbivore populations and damage. He has a strong interest in developing and promoting wildlife survey and analysis methods that can provide the best quality information for managers and decision-makers.
Adam Stone Ecologist ***Field work, statistical analyses, reporting***	Master of Environmental Management, University of Queensland 2017 Bachelor of Science, Queensland University of Technology 2012	Adam Stone has worked as an ecologist in both academic and consulting positions since 2012. He specialises in the ecology of volant (flying) vertebrates, terrestrial fauna trapping and conservation-oriented management. Adam has worked across a diverse range of environmental and biodiversity related fields in a variety of Australia's landscapes. He has worked on a diverse range of projects including Surveying and describing new species of Antechinus, assessing the impact of Red Deer on Australian native vegetation, marine turtle and bird monitoring and, microbat behavioural studies.
Tegan Dinsdale Ecologist ***Field work, reporting, mapping***	Bachelor of Science (Honours), University of Adelaide, 2020 Bachelor of Science (Animal Behaviour), Flinders University, 2019	Tegan Dinsdale is a Wildlife Ecologist who began working with Ecosure in 2021. She has gained extensive knowledge in animal behaviour, conservation and ecology through her studies, as well as practical experience in conducting flora and fauna surveys and research in Queensland, South Australia and internationally. Tegan has experience in animal handling, camera trapping, conducting flora and fauna surveys, scientific report writing, GIS, and data analysis.

Appendix 2 Camera locations

Camera ID	Latitude	Longitude	Offset cluster	track type	Bait status
1	-26.06689866	152.6341217	Curra	track	no
2	-26.06752598	152.6307735	Curra	bush	no
3	-26.06578114	152.6325329	Curra	dry creek bed	no
4	-26.06367079	152.6327147	Curra	dry creek bed	no
5	-26.06621698	152.6289581	Curra	dry creek bed	no
6	-26.06500652	152.6268406	Curra	track	no
7	-26.0713137	152.6286546	Curra	track	no
8	-26.06933537	152.6295363	Curra	bush	no
9	-26.06774501	152.6274674	Curra	dry creek bed	no
10	-26.07054262	152.6318023	Curra	open area	no
11	-26.0728995	152.6305424	Curra	open area	no
12	-26.07034008	152.6261145	Curra	track	no
13	-26.0712464	152.624468	Curra	track	no
14	-26.073694	152.6276865	Curra	track	no
15	-26.07535851	152.6295	Curra	track	no
16	-26.06070081	152.6236029	Curra	bush	no
17	-26.06401956	152.6246583	Curra	dry creek bed	no
18	-26.05906106	152.6214103	Curra	track	no
19	-26.06159327	152.619652	Curra	dry creek bed	no
20	-26.06281453	152.6219872	Curra	dry creek bed	no
21	-26.06285097	152.6075039	Curra	open area	no
22	-26.06396805	152.6098339	Curra	bush	no
23	-26.06477047	152.6123212	Curra	track	no
24	-26.06085953	152.6090928	Curra	bush	no
25	-26.06046424	152.6038921	Curra	open area	no
26	-26.05867379	152.6046594	Curra	bush	no
27	-26.05970026	152.6069909	Curra	dry creek bed	no

Camera ID	Latitude	Longitude	Offset cluster	track type	Bait status
28	-26.06203717	152.6058788	Curra	track	no
29	-26.07100346	152.6233204	Curra	track	no
30	-26.0687606	152.6239444	Curra	track	no
31	-26.0665648	152.6247435	Curra	dry creek bed	no
32	-26.06600099	152.6231489	Curra	bush	no
33	-26.0650017	152.6214812	Curra	track	no
34	-26.06781281	152.621838	Curra	bush	no
35	-26.06949084	152.6199063	Curra	track	no
36	-26.0664296	152.6189289	Curra	track	no
37	-26.06856087	152.6182229	Curra	track	no
38	-26.0673096	152.6159884	Curra	track	no
39	-26.06616333	152.6139234	Curra	bush	no
40	-26.0643632	152.6152434	Curra	bush	no
41	-26.0620703	152.6167612	Curra	bush	no
42	-26.06375783	152.619019	Curra	dry creek bed	no
43	-26.06559583	152.6174105	Curra	bush	no
44	-26.24631604	152.7147561	Woondum	bush	no
45	-26.24470645	152.7138185	Woondum	bush	yes
46	-26.24734938	152.7127294	Woondum	bush	no
47	-26.24517043	152.7114821	Woondum	track	no
48	-26.24426623	152.7092284	Woondum	track	no
49	-26.24632198	152.7089017	Woondum	small clearing	yes
50	-26.24884751	152.7099158	Woondum	bush	yes
51	-26.2501453	152.7108203	Woondum	bush	yes
52	-26.25260705	152.7124499	Woondum	bush	yes
53	-26.2494268	152.713428	Woondum	dry creek bed	yes
54	-26.23812569	152.7002494	Woondum	bush	no
55	-26.23999951	152.7020752	Woondum	bush	yes
56	-26.24172105	152.7026476	Woondum	bush	no

Camera ID	Latitude	Longitude	Offset cluster	track type	Bait status
57	-26.15308293	152.6799568	Victory Heights	open area	no
58	-26.15263404	152.68241	Victory Heights	track	no
59	-26.15384386	152.6840236	Victory Heights	track	no
60	-26.15594747	152.6820167	Victory Heights	bush	no
61	-26.15735117	152.6838111	Victory Heights	dry creek bed	no
62	-26.15617498	152.6859552	Victory Heights	track	no
63	-26.15896077	152.6854791	Victory Heights	dry creek bed	no
64	-26.16512587	152.6776816	Victory Heights	dry creek bed	no
65	-26.16294328	152.6777345	Victory Heights	track	no
66	-26.16093566	152.6760406	Victory Heights	track	no
67	-26.15827216	152.6785035	Victory Heights	dry creek bed	no
68	-26.16026079	152.6784344	Victory Heights	track	no

Appendix 3 Statistical analysis coding

The following script is the input code (including analytical notation) used to analyse 2021 (baseline), 2022, 2023 and 2024 data in R Studio. The 2021, 2022, 2023 and 2024 databases are names 'Pest_data_R_2021', 'Pest_data_R_2022', 'Pest_Data_R_2023' and 'Pest_Data_R_2024', respectively.

```
library(ggplot2)
library(lme4)

#2024 data

#  { AB:
Pest_data_R_2021 <- read.csv("Pest_data_R_2021.csv")
Pest_data_R_2022 <- read.csv("Pest_data_R_2022.csv")
Pest_data_R_2023 <- read.csv("Pest_data_R_2023.csv")
Pest_data_R_2024 <- read.csv("Pest_data_R_2024.csv")
head(Pest_data_R_2024)
# }

dat24 <- Pest_data_R_2024


dog <- subset(dat24, dat24$common == "wild dog")
fox <- subset(dat24, dat24$common == "red fox")
cat <- subset(dat24, dat24$common == "feral cat")
pig <- subset(dat24, dat24$common == "feral pig")

#pigs and cats only in curra checked

pig <- pig %>%
  filter(site == "curra")
cat <- cat %>%
  filter(site == "curra")

library(tidyverse)
spp_sum <- Pest_data_R_2024 %>%
  group_by(site, common) %>%
  summarise(n = n(),
            count = sum(count))
spp_sum

#activity indices for wild dogs
dog1 <- lmer(count ~ site-1 + (1|track/camera), data = dog)
dog1_sum <- summary(dog1)
print(dog1_sum)

plot(dog1)

#expected number of dog detections per camera per day
gi_dog1 <- coefficients(dog1_sum)[, "Estimate"]
print(gi_dog1)

#confidence intervals for the estimates
lo_dog1 <- coefficients(dog1_sum)[, "Estimate"] - 1.96 * coefficients(dog1_sum)[, "Std. Error"]
up_dog1 <- coefficients(dog1_sum)[, "Estimate"] + 1.96 * coefficients(dog1_sum)[, "Std. Error"]
print(lo_dog1)
print(up_dog1)


#activity indices for red foxes
fox1 <- lmer(count ~ site-1 + (1|track/camera), data = fox)
fox1_sum <- summary(fox1)
print(fox1_sum)

#expected number of fox detections per camera per day
gi_fox1 <- coefficients(fox1_sum)[, "Estimate"]
print(gi_fox1)

#confidence intervals for the estimates
```

```
lo_fox1 <- coefficients(fox1_sum)[, "Estimate"] - 1.96 * coefficients(fox1_sum)[, "Std. Error"]
up_fox1 <- coefficients(fox1_sum)[, "Estimate"] + 1.96 * coefficients(fox1_sum)[, "Std. Error"]
print(lo_fox1)
print(up_fox1)


#activity indices for feral cat
cat1 <- lmer(count ~ 1 + (1|track/camera), data = cat)
cat1_sum <- summary(cat1)
print(cat1_sum)

#expected number of cat detections per camera per day
gi_cat1 <- coefficients(cat1_sum)[, "Estimate"]
print(gi_cat1)

#confidence intervals for the estimates
lo_cat1 <- coefficients(cat1_sum)[, "Estimate"] - 1.96 * coefficients(cat1_sum)[, "Std. Error"]
up_cat1 <- coefficients(cat1_sum)[, "Estimate"] + 1.96 * coefficients(cat1_sum)[, "Std. Error"]
print(lo_cat1)
print(up_cat1)


#activity indices for feral pig ----
pig1 <- lmer(count ~ 1 + (1|camera), data = pig)

pig1_sum <- summary(pig1)
print(pig1_sum)

#expected number of pig detections per camera per day
gi_pig1 <- coefficients(pig1_sum)[, "Estimate"]
print(gi_pig1)

#confidence intervals for the estimates
lo_pig1 <- coefficients(pig1_sum)[, "Estimate"] - 1.96 * coefficients(pig1_sum)[, "Std. Error"]
up_pig1 <- coefficients(pig1_sum)[, "Estimate"] + 1.96 * coefficients(pig1_sum)[, "Std. Error"]
print(lo_pig1)
print(up_pig1)

sites <- rep(unique(Pest_data_R_2024$site), 4)
ggdat <- data.frame(site = sites,
                    species = c(rep("dog", 3),
                                rep("fox", 3),
                                rep("cat", 3),
                                rep("pig", 3)),
                    value = c(gi_dog1,NA,
                              gi_fox1,
                              gi_cat1[1], NA, gi_cat1[2],
                              gi_pig1, NA, NA),
                    ci_lo = c(lo_dog1,NA,
                              lo_fox1,
                              lo_cat1[1], NA, lo_cat1[2],
                              lo_pig1, NA, NA),
                    ci_up = c(up_dog1,NA,
                              up_fox1,
                              up_cat1[1], NA, up_cat1[2],
                              up_pig1, NA, NA),
                    year="2022")

ggplot(ggdat) +
  geom_point(aes(x=site, y=value)) +
  geom_linerange(aes(x=site, ymin=ci_lo, ymax=ci_up)) +
  facet_wrap(~species, scales='free')


## BELOW IS SCRIPT FROM LAST YEAR, 2021 script repeated for all previous years?

## Repeat for 2023 data ----

dat23 <- Pest_data_R_2023

dog23a <- subset(dat23, dat23$common == "wild dog")
fox23a <- subset(dat23, dat23$common == "red fox")
cat23a <- subset(dat23, dat23$common == "feral cat")
pig23a <- subset(dat23, dat23$common == "feral pig")
```

```
spp_sum <- dat23 %>%
  group_by(site, common) %>%
  summarise(n = n(),
            count = sum(count))
spp_sum

## There were no wild dog detections at Victory, so site removed checked
dog <- dog %>%
  filter(site != "victory")
## Cats were only detected at Curra
cat <- cat %>%
  filter(site == "curra")
## Pigs were only detected at Curra
pig <- pig %>%
  filter(site == "curra")

#activity indices for wild dogs 2023 ----
dog23 <- lmer(count ~ site-1 + (1|track/camera), data = dog23a)
(dog23_sum <- summary(dog23))

#expected number of dog detections per camera per day
gi_dog23 <- coefficients(dog23_sum)[, "Estimate"]
print(gi_dog23)

#confidence intervals for the estimates
lo_dog23 <- coefficients(dog23_sum)[, "Estimate"] - 1.96 * coefficients(dog23_sum)[, "Std. Error"]
up_dog23 <- coefficients(dog23_sum)[, "Estimate"] + 1.96 * coefficients(dog23_sum)[, "Std. Error"]
lo_dog23
up_dog23

#activity indices for red foxes 2023 ----
fox23 <- lmer(count ~ site-1 + (1|track/camera), data = fox23a)
(fox23_sum <- summary(fox23))

#expected number of fox detections per camera per day
gi_fox23 <- coefficients(fox23_sum)[, "Estimate"]
gi_fox23

#confidence intervals for the estimates
lo_fox23 <- coefficients(fox23_sum)[, "Estimate"] - 1.96 * coefficients(fox23_sum)[, "Std. Error"]
up_fox23 <- coefficients(fox23_sum)[, "Estimate"] + 1.96 * coefficients(fox23_sum)[, "Std. Error"]
lo_fox23
up_fox23

# activity indices for feral cats 2023 ----
# We can drop the 'track' effect again which has a variance of 0 and causes a poor fit
cat23 <- lmer(count ~ site-1 + (1|camera), data = cat23a)
(cat23_sum <- summary(cat23))

#expected number of cat detections per camera per day
gi_cat23 <- coefficients(cat23_sum)[, "Estimate"]
gi_cat23

#confidence intervals for the estimates
lo_cat23 <- coefficients(cat23_sum)[, "Estimate"] - 1.96 * coefficients(cat23_sum)[, "Std. Error"]
up_cat23 <- coefficients(cat23_sum)[, "Estimate"] + 1.96 * coefficients(cat23_sum)[, "Std. Error"]
lo_cat23
up_cat23


#activity indices for feral pig ----
pig23 <- lmer(count ~ 1 + (1|camera), data = pig23a)

pig23_sum <- summary(pig23)
print(pig23_sum)

#expected number of pig detections per camera per day
gi_pig23 <- coefficients(pig23_sum)[, "Estimate"]
gi_pig23

#confidence intervals for the estimates
lo_pig23 <- coefficients(pig23_sum)[, "Estimate"] - 1.96 * coefficients(pig23_sum)[, "Std. Error"]
up_pig23 <- coefficients(pig23_sum)[, "Estimate"] + 1.96 * coefficients(pig23_sum)[, "Std. Error"]
lo_pig23
up_pig23
```

```
## First, put the estimates into a dataframe
sites <- rep(unique(dat23$site), 4)
ggdat23 <- data.frame(site = sites,
                      species = c(rep("dog", 3),
                                  rep("fox", 3),
                                  rep("cat", 3),
                                  rep("pig", 3)),
                      value = c(gi_dog23,NA,
                                gi_fox23,
                                gi_cat23[1], NA, gi_cat23[2],
                                gi_pig23, NA, NA),
                      ci_lo = c(lo_dog23,NA,
                                lo_fox23,
                                lo_cat23[1], NA, lo_cat23[2],
                                lo_pig23, NA, NA),
                      ci_up = c(up_dog23,NA,
                                up_fox23,
                                up_cat23[1], NA, up_cat23[2],
                                up_pig23, NA, NA),
                      year = "2023")

ggplot(ggdat23) +
  geom_point(aes(x=site, y=value)) +
  geom_linerange(aes(x=site, ymin=ci_lo, ymax=ci_up)) +
  facet_wrap(~species)


## Repeat for 2022 data ----


dat22 <- Pest_data_R_2022

dog22a <- subset(dat22, dat22$common == "wild dog")
fox22a <- subset(dat22, dat22$common == "red fox")
cat22a <- subset(dat22, dat22$common == "feral cat")
pig22a <- subset(dat22, dat22$common == "feral pig")

spp_sum <- dat22 %>%
  group_by(site, common) %>%
  summarise(n = n(),
            count = sum(count))
spp_sum

## There were no wild dog detections at Victory, so remove that site from dog checked
dog <- dog %>%
  filter(site != "victory")
## Also, no cats at Woondum
cat <- cat %>%
  filter(site != "woondum")
## Pigs were only detected at Curra
pig <- pig %>%
  filter(site == "curra")

#activity indices for wild dogs 2022 ----
dog22 <- lmer(count ~ site-1 + (1|track/camera), data = dog22a)
(dog22_sum <- summary(dog22))

#expected number of dog detections per camera per day
gi_dog22 <- coefficients(dog22_sum)[, "Estimate"]
print(gi_dog22)

#confidence intervals for the estimates
lo_dog22 <- coefficients(dog22_sum)[, "Estimate"] - 1.96 * coefficients(dog22_sum)[, "Std. Error"]
up_dog22 <- coefficients(dog22_sum)[, "Estimate"] + 1.96 * coefficients(dog22_sum)[, "Std. Error"]
lo_dog22
up_dog22

#activity indices for red foxes 2022 ----
fox22 <- lmer(count ~ site-1 + (1|track/camera), data = fox22a)
(fox22_sum <- summary(fox22))

#expected number of fox detections per camera per day
gi_fox22 <- coefficients(fox22_sum)[, "Estimate"]
gi_fox22
```

```
#confidence intervals for the estimates
lo_fox22 <- coefficients(fox22_sum)[, "Estimate"] - 1.96 * coefficients(fox22_sum)[, "Std. Error"]
up_fox22 <- coefficients(fox22_sum)[, "Estimate"] + 1.96 * coefficients(fox22_sum)[, "Std. Error"]
lo_fox22
up_fox22

# activity indices for feral cats 2022 ----
# We can drop the 'track' effect again which has a variance of 0 and causes a poor fit
cat22 <- lmer(count ~ site-1 + (1|camera), data = cat22a)
(cat22_sum <- summary(cat22))

#expected number of cat detections per camera per day
gi_cat22 <- coefficients(cat22_sum)[, "Estimate"]
gi_cat22

#confidence intervals for the estimates
lo_cat22 <- coefficients(cat22_sum)[, "Estimate"] - 1.96 * coefficients(cat22_sum)[, "Std. Error"]
up_cat22 <- coefficients(cat22_sum)[, "Estimate"] + 1.96 * coefficients(cat22_sum)[, "Std. Error"]
lo_cat22
up_cat22


#activity indices for feral pig ----
pig22 <- lmer(count ~ 1 + (1|camera), data = pig22a)

pig22_sum <- summary(pig22)
print(pig22_sum)

#expected number of pig detections per camera per day
gi_pig22 <- coefficients(pig22_sum)[, "Estimate"]
gi_pig22

#confidence intervals for the estimates
lo_pig22 <- coefficients(pig22_sum)[, "Estimate"] - 1.96 * coefficients(pig22_sum)[, "Std. Error"]
up_pig22 <- coefficients(pig22_sum)[, "Estimate"] + 1.96 * coefficients(pig22_sum)[, "Std. Error"]
lo_pig22
up_pig22

## First, put the estimates into a dataframe
sites <- rep(unique(dat22$site), 4)
ggdat22 <- data.frame(site = sites,
                      species = c(rep("dog", 3),
                                  rep("fox", 3),
                                  rep("cat", 3),
                                  rep("pig", 3)),
                      value = c(gi_dog22,NA,
                                gi_fox22,
                                gi_cat22[1], NA, gi_cat22[2],
                                gi_pig22, NA, NA),
                      ci_lo = c(lo_dog22,NA,
                                lo_fox22,
                                lo_cat22[1], NA, lo_cat22[2],
                                lo_pig22, NA, NA),
                      ci_up = c(up_dog22,NA,
                                up_fox22,
                                up_cat22[1], NA, up_cat22[2],
                                up_pig22, NA, NA),
                      year = "2022")

ggplot(ggdat22) +
  geom_point(aes(x=site, y=value)) +
  geom_linerange(aes(x=site, ymin=ci_lo, ymax=ci_up)) +
  facet_wrap(~species)


## Repeat for 2021 data, script unchanged from last year ----


dat21 <- Pest_data_R_2021

dog21a <- subset(dat21, dat21$common == "wild dog")
fox21a <- subset(dat21, dat21$common == "red fox")
```

```
cat21a <- subset(dat21, dat21$common == "feral cat")
pig21a <- subset(dat21, dat21$common == "feral pig")

spp_sum <- dat21 %>%
  group_by(site, common) %>%
  summarise(n = n(),
            count = sum(count))
spp_sum

## There were no wild dog detections at Victory again
dog21a <- dog21a %>%
  filter(site != "victory")
## Only one cat at Woondum - not enough to calculate an index
cat21a <- cat21a %>%
  filter(site != "woondum")
## Pigs were only detected at Curra
pig21a <- pig21a %>%
  filter(site == "curra")


#activity indices for wild dogs 2021 ----
dog21 <- lmer(count ~ site-1 + (1|track/camera), data = dog21a)
(dog21_sum <- summary(dog21))

#expected number of dog detections per camera per day
gi_dog21 <- coefficients(dog21_sum)[, "Estimate"]
print(gi_dog21)

#confidence intervals for the estimates
lo_dog21 <- coefficients(dog21_sum)[, "Estimate"] - 1.96 * coefficients(dog21_sum)[, "Std. Error"]
up_dog21 <- coefficients(dog21_sum)[, "Estimate"] + 1.96 * coefficients(dog21_sum)[, "Std. Error"]
lo_dog21
up_dog21

#activity indices for red foxes 2021 ----
fox21 <- lmer(count ~ site-1 + (1|track/camera), data = fox21a)
(fox21_sum <- summary(fox21))

#expected number of fox detections per camera per day
gi_fox21 <- coefficients(fox21_sum)[, "Estimate"]
gi_fox21

#confidence intervals for the estimates
lo_fox21 <- coefficients(fox21_sum)[, "Estimate"] - 1.96 * coefficients(fox21_sum)[, "Std. Error"]
up_fox21 <- coefficients(fox21_sum)[, "Estimate"] + 1.96 * coefficients(fox21_sum)[, "Std. Error"]
lo_fox21
up_fox21



# activity indices for feral cats 2021 ----
# We can drop the 'track' effect again which has a variance of 0 and causes a poor fit
cat21 <- lmer(count ~ site-1 + (1|camera), data = cat21a)
(cat21_sum <- summary(cat21))

#expected number of cat detections per camera per day
gi_cat21 <- coefficients(cat21_sum)[, "Estimate"]
gi_cat21

#confidence intervals for the estimates
lo_cat21 <- coefficients(cat21_sum)[, "Estimate"] - 1.96 * coefficients(cat21_sum)[, "Std. Error"]
up_cat21 <- coefficients(cat21_sum)[, "Estimate"] + 1.96 * coefficients(cat21_sum)[, "Std. Error"]
lo_cat21
up_cat21


#activity indices for feral pig ----
pig21 <- lmer(count ~ 1 + (1|camera), data = pig21a)

pig21_sum <- summary(pig21)
print(pig21_sum)

#expected number of pig detections per camera per day
gi_pig21 <- coefficients(pig21_sum)[, "Estimate"]
gi_pig21
```

```
#confidence intervals for the estimates
lo_pig21 <- coefficients(pig21_sum)[, "Estimate"] - 1.96 * coefficients(pig21_sum)[, "Std. Error"]
up_pig21 <- coefficients(pig21_sum)[, "Estimate"] + 1.96 * coefficients(pig21_sum)[, "Std. Error"]
lo_pig21
up_pig21


## Plot it all to see if it makes sense ----

## First, put the estimates into a dataframe
sites <- rep(unique(dat21$site), 4)
ggdat21 <- data.frame(site = sites,
                      species = c(rep("dog", 3),
                                  rep("fox", 3),
                                  rep("cat", 3),
                                  rep("pig", 3)),
                      value = c(gi_dog21,NA,
                                gi_fox21,
                                gi_cat21[1], NA, gi_cat21[2],
                                gi_pig21, NA, NA),
                      ci_lo = c(lo_dog21,NA,
                                lo_fox21,
                                lo_cat21[1], NA, lo_cat21[2],
                                lo_pig21, NA, NA),
                      ci_up = c(up_dog21,NA,
                                up_fox21,
                                up_cat21[1], NA, up_cat21[2],
                                up_pig21, NA, NA),
                      year = "2021")

ggplot(ggdat21) +
  geom_point(aes(x=site, y=value)) +
  geom_linerange(aes(x=site, ymin=ci_lo, ymax=ci_up)) +
  facet_wrap(~species)


## Plot all? years together ----

ggdat_all <- rbind(ggdat, ggdat21, ggdat22, ggdat23) %>%
  arrange(species, site, year)
pd2 <- position_dodge2(width = 0.5)

ggplot(ggdat_all) +
  geom_point(aes(x=site, y=value, colour=year), position=pd2) +
  geom_linerange(aes(x=site, ymin=ci_lo, ymax=ci_up, colour=year), position=pd2) +
  facet_wrap(~species, scales='free')
```

Appendix 4 Sample camera images

The following images provide a sample of wild dog/dingo images captured on camera 13 and 18 (Curra) on the 25/02/2024 and 11/03/2024. This pack of dogs/dingoes was observed traversing tracks throughout Curra. Sometimes these dogs/dingoes were seen by themselves, and sometimes in groups of multiple individuals. Images were reviewed to identify individuals.


2024-02-25 6:06:32 AM M 3/10
21°C
HF2 PRO COVERT
RECONYX


2024-02-25 6:06:33 AM M 4/10
21°C
HF2 PRO COVERT
RECONYX


2024-02-25 6:06:33 AM M 4/10
21°C
HF2 PRO COVERT
RECONYX


2024-02-25 6:06:34 AM M 5/10
21°C
HF2 PRO COVERT
RECONYX


2024-02-25 6:06:35 AM M 6/10
21°C
HF2 PRO COVERT
RECONYX


2024-02-25 6:06:35 AM M 7/10
21°C
HF2 PRO COVERT
RECONYX


2024-02-25 6:06:36 AM M 8/10
21°C
HF2 PRO COVERT
RECONYX

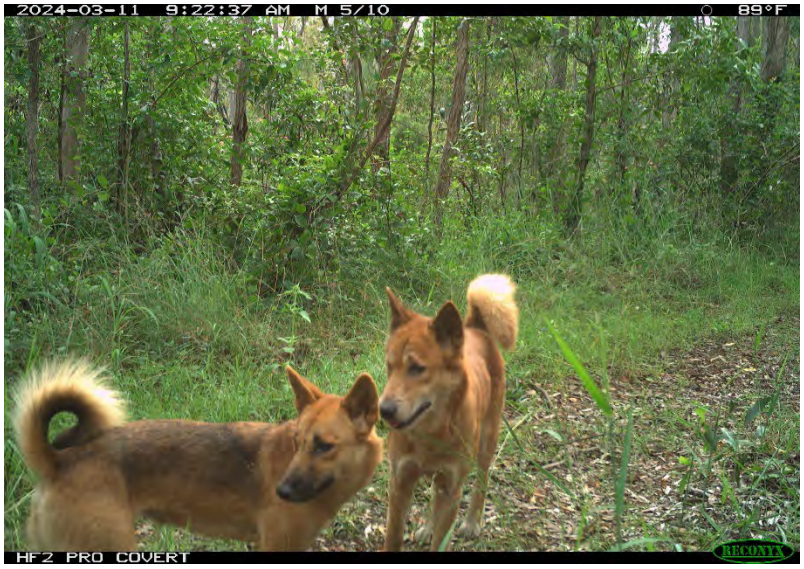

2024-02-25 6:06:37 AM M 10/10
21°C
HF2 PRO COVERT
RECONYX


2024-03-11 9:22:20 AM M 1/10
89°F
HF2 PRO COVERT
RECONYX


2024-03-11 9:22:34 AM M 1/10
89°F
HF2 PRO COVERT
RECONYX


2024-03-11 9:22:35 AM M 2/10
89°F
HF2 PRO COVERT
RECONYX


2024-03-11 9:22:36 AM M 4/10
89°F
HF2 PRO COVERT
RECONYX


2024-03-11 9:22:37 AM M 5/10
89°F
HF2 PRO COVERT
RECONYX


2024-03-11 9:22:37 AM M 6/10
89°F
HF2 PRO COVERT
RECONYX

Koala observed at Woondum (Camera 45) on 13/03/2024.

Appendix 5 Statistical output summary

		Activity index				Lower confidence interval				Upper confidence interval			
Site	**Pest animal**	**2021**	**2022**	**2023**	**2024**	**2021**	**2022**	**2023**	**2024**	**2021**	**2022**	**2023**	**2024**
Curra	red fox	0.015	0.00518	0.00111	0.00143000	0.00771	0.00222	0.00251	0.00047	0.0292	0.0121	0.00487	0.00434
	wild dog	0.00842	0.01283	0.00123	0.0081	0.003188	0.005429	0.0000576	0.00285	0.0223	0.0303	0.02629	0.02301
	feral cat	0.001152	0.00229	0.00031957	0.000011333	0.000282	0.000838	0.00003825	0.00000019	0.00471	0.00625	0.00267	0.00102
	feral pig	0.000169	0.002313	0.001642	0.00001711	0.00001420	0.00042884	0.00061538	0.00000077	0.002012	0.012476	0.0043814	0.00038
Victory Heights	red fox	0.0115	0.01846	0.00111	0.00147000	0.00383	0.00704	0.000159	0.000205	0.0345	0.0484	0.00782	0.01049
	wild dog	0.00261	0.00287	0.011987	0	0.000509	0.000655	0.0000106	0	0.0134	0.0125	0.00691	0
	feral cat	0.000349	0	0	0	0.000264	0	0	0	0.00462	0	0	0
	feral pig	0	0	0	0	0	0	0	0	0	0	0	0
Woondum	red fox	0.0424	0.03117	0.00375	0	0.01444	0.011083	0.000694	0	0.1248	0.0897	0.02031	0
	wild dog	0	0	0	0.00048	0	0	0	0.0000494	0	0	0	0.00466
	feral cat	0.00091	0.00316	0	0	0.0000984	0.000601	0	0	0.00842	0.01662	0	0
	feral pig	0	0	0	0	0	0	0	0	0	0	0	0

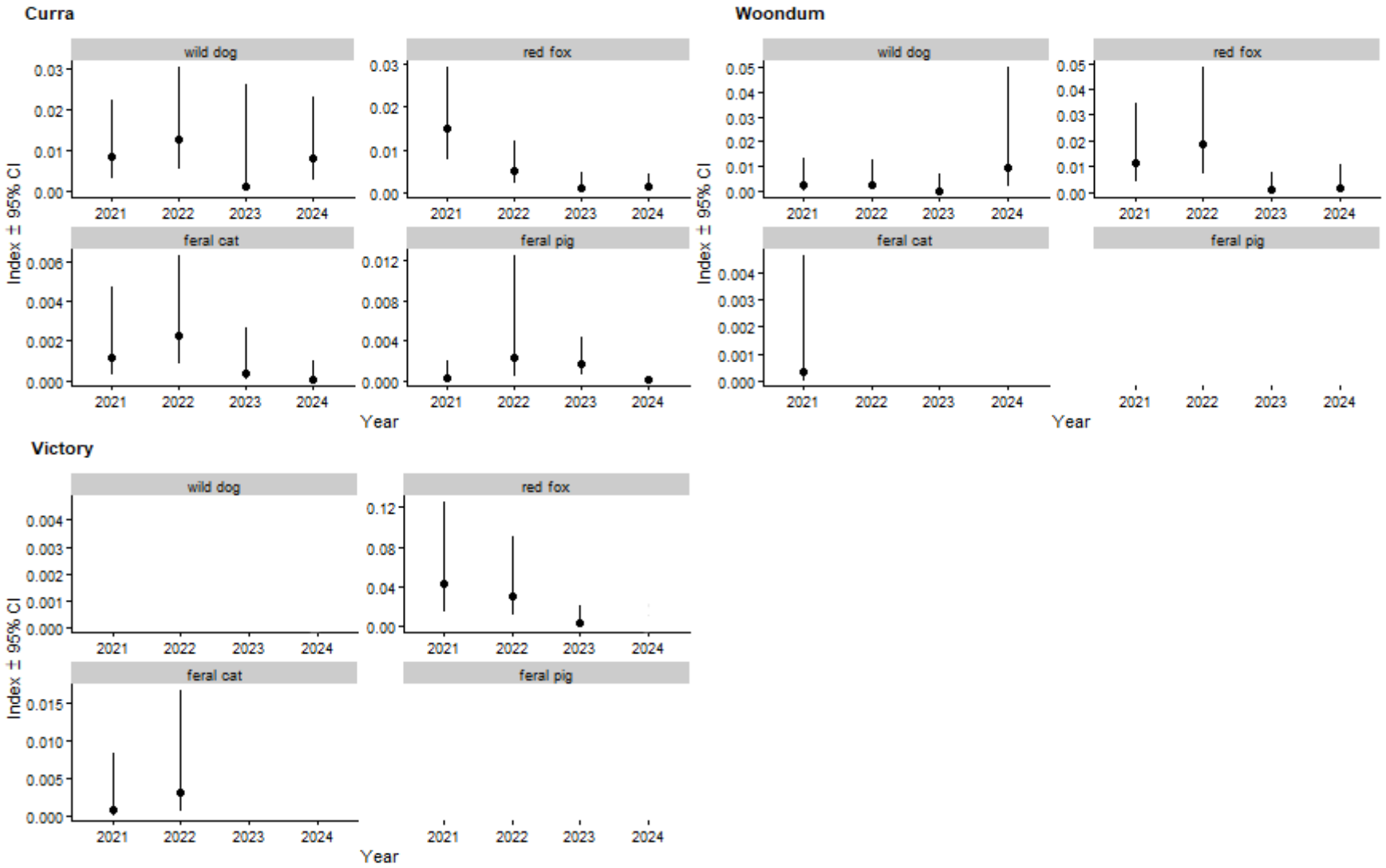


Figure 9 Annual activity indices calculated for each species at each site.

Appendix 6 Dog / dingo dietary analysis

No.	Site	Sample	Scat specie	Content species	Content species	
1	Gympie - Curra	Scat	Dog	Rattus rattus		
2	Gympie - Curra	Scat	Dog	Felis catus		
3	Gympie - Curra	Scat	Dog	Felis catus	Rattus sp.	

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Revision History

Revision No.	Revision date	Details	Prepared by	Reviewed by	Approved by
00	10/06/2024	C2CD Offset Pest Animal Control Survey – Year 3 Report	Adam Stone, Wildlife Biologist Tegan Dinsdale Wildlife Biologist	Jess Bracks, Principal Wildlife Biologist	Jess Bracks, Principal Wildlife Biologist
01	20/11/2024	C2CD Offset Pest Animal Control Survey – Year 3 Report		Cameron Vacher, Department of Transport and Main Roads	Jess Bracks, Principal Wildlife Biologist

Distribution List

Copy #	Date	Type	Issued to	Name
1	20/11/2024	Electronic	Department of Transport and Main Roads	Cameron Vacher
2	20/11/2024	Electronic	Ecosure	Administration

Citation: Ecosure, 2024, *Offset Pest Animal Control Survey – Year 3 Report*, Report to Department of Transport and Main Roads, Brisbane

Report compiled by Ecosure Pty Ltd

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