GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

An assessment of ngwayir (western ringtail possum) in the Perup Sanctuary to inform a potential translocation to the Perup Sanctuary: Progress report

Version: 1.0 Approved by: Lesley Gibson

Last Updated:

Custodian: Adrian Wayne Review date: NA

Version number	Date approved DD/MM/YYYY	Approved by	Brief Description
1.0	13/12/2022	Lesley Gibson	

Biodiversity and Conservation Science

PARKS AND WILDLIFE SERVICE

An assessment of ngwayir (western ringtail possum) in the Perup Sanctuary to inform a potential translocation to the Perup Sanctuary: Progress report.

December 2022

GOVERNMENT OF WESTERN AUSTRALIA

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June 2022

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The recommended reference for this publication is: Wayne, A.F., Maxwell, M.A., Wayne, J.C., Virgo, M. (2022). An assessment of ngwayir (western ringtail possum) in the Perup Sanctuary to inform a potential translocation to the Perup Sanctuary: Progress Report. Department of Biodiversity, Conservation and Attractions, Perth, Western Australia.

This document is available in alternative formats on request.

Cover image: Adult female and subadult ngwayir (western ringtail possum, *Pseudocheirus occidentalis*) in the Perup Sanctuary, Western Australia.

Contents

Acknowledgments

We acknowledge the Noongar people as the Traditional Owners of the land upon which this work was conducted. This work was conducted by the Department of Biodiversity, Conservation and Attractions, (DBCA) under a services agreement between DBCA's Parks and Wildlife Service (Regional and Fire Management Services, Warren Region) and the South West Catchments Council (SWCC), as part of a larger project aimed at establishing and maintaining feral free enclosures and funded by the Australian Government's National Landcare Program (NLP2). DBCA co-funded and conducted this work. Marika Maxwell, Adrian Barrett, and Adrian Wayne, all from Biodiversity and Conservation Science, were the spotlighters. The catching team were Julia Wayne, Madi Read, Mark Virgo, Jodie Millar, and Ian Wheeler from Parks and Wildlife Service, Clint Connor (contractor), Tracy Robins, and Neil Taylor (volunteers). Preliminary distance sampling modelling was conducted by Natasha Harrison using R code kindly provided by Joanne Potts.

Summary

The ngwayir (western ringtail possum, *Pseudocheirus occidentalis*) is currently listed as *Critically Endangered.* A survey to determine the current spatial distribution and abundance of ngwayir (western ringtail possum, *Pseudocheirus occidentalis*) within the Perup Sanctuary was conducted in November 2022. Pedestrian-based spotlight surveys along 24 transects totalling 39.6 km resulted in a total of 126 ngwayir individuals and 217 koomal (common brushtail possum, *Trichosurus vulpecula*) being detected. A preliminary distance sampling model estimated the population size to be 155 ngwayir individuals (95% Confidence Interval 127.5 - 190.3) and 350 koomal individuals (95% CI 272.6 - 451.2) across 423 ha. Twenty-eight individuals were hand-captured to take tissue samples for genetic analysis and record demographic and biometric information. Analyses of these data and samples are underway. The final results from this study can be used to inform conservation and management of the ngwayir insurance population within the Perup Sanctuary.

1 Introduction

This project is intended to inform the conservation and management of the ngwayir (western ringtail possum, *Pseudocheirus occidentalis*) with a particular focus on the wild population within the Upper Warren region and to assess the merits and feasibility of improving the value of the insurance population in the Perup Sanctuary. This includes having a better understanding of

- the status of the wild ngwayir population within the Upper Warren, which has undergone >95% decline in the last 20 years (e.g., what are the conservation values of the population and the risks to the population, how great is the need for an insurance population, etc),
- what is the status and characteristics of the ngwayir population within the Perup Sanctuary (e.g., what is the size of the population, is it at or close to carrying capacity, what is the genetic diversity, representativeness, and relatedness to other ngwayir populations)?
- whether genetic augmentation / supplementation is needed to improve the value of the insurance population within the Perup Sanctuary, and if so, how is this best done? For example, provide an indication of appropriate potential source sites and help determine safe harvest numbers for a possible translocation for the purposes of genetic augmentation from the wild to the Perup Sanctuary.

The specific purpose of this survey was to conduct a demographic and genetic assessment of the ngwayir within the Perup Sanctuary.

Project questions were;

- What is the current size and distribution of ngwayir population within the Perup sanctuary?
- What has been the survivorship and relative genetic contribution of the ngwayir individuals and cohorts translocated into the sanctuary?
- What is the health, condition, and genetic diversity of ngwayir within the Perup Sanctuary?

This work is part of a collaborative project (2021 – 2023) involving Parks and Wildlife Service (PWS) and Biodiversity and Conservation Science (BCS), under contract with South West Catchments Council (SWCC) with funds from the Commonwealth's National Landcare Program (NLP2).

2 Background

2.1 The ngwayir

The ngwayir (pronounced n-wa-yer; or western ringtail possum, *Pseudocheirus occidentalis*) is one of 21 mammals identified as a priority species in the Australian Government's Threatened Species Action Plan 2022-2032 (DCCEEW 2022). Endemic to southwestern Australia, the ngwayir has substantially declined in numbers and range since European settlement (1826) and is currently listed as 'Critically Endangered' under the Western Australian *Biodiversity Conservation Act of 2016* and the Australian *Environment Protection and Biodiversity Act of 1999.*

The current threatened status is due in large part to the rapid and substantial decline of the species in the Upper Warren region (an area roughly between Lake Muir and the towns of Manjimup, Bridgetown and Boyup Brook, in southwestern Australia; Wayne et al. 2012, 2015, 2017; Woinarski et al. 2014). Of the eight genetic clusters identified for the species, the Upper Warren cluster has the greatest genetic diversity (heterozygosity and mean number of alleles per marker; White et al. 2021). The key threats to this folivorous, arboreal and nocturnal marsupial include habitat loss and fragmentation as a direct result of human development, introduced predators, climate change, timber harvesting and fire (Department of Parks and Wildlife 2017).

2.2 The Upper Warren

The Upper Warren region is one of Australia's most important areas for the conservation of threatened native mammals, supporting some of the largest and genetically most diverse remnant populations of species, several of which previously had ranges across much of southern Australia (e.g., the Critically Endangered woylie (*Bettongia penicillata*), the Endangered numbat (*Myrmecobius fasciatus*), and Vulnerable chuditch (*Dasyurus geoffroii*)).

2.3 The ngwayir population in the Upper Warren

- The ngwayir is one of at least seven species of native mammal to have undergone rapid and catastrophic declines (80-100%) since the mid-1990s in the Upper Warren region of southwestern Australia (Wayne et al. 2017).
- The best estimate for the size of the ngwayir population is 7,103 (6,052 – 8,335 95%CI) in 2022, within an area of 38,349 ha containing the current 'hotspot' with the highest ngwayir densities and constituting the vast majority of the extant population within the Upper Warren region (Wayne et al. 2022b).
- The Upper Warren region supports the largest remaining ngwayir population in the jarrah forest and a substantial portion of the extant population and its genetic diversity (White et al. 2021).
- The ngwayir population in the Upper Warren remains very important to the conservation and recovery of the species given its size and genetics. Despite having undergone substantial declines (>99% in some areas) since 1998

(Wayne et al. 2005, 2012 and 2017), the Upper Warren population remains large relative to other extant populations on the west coast and south coast of Western Australia, which combined, total more than 20,000 individuals (Teale and Potts 2020).

- Introduced predators, particularly the cat (*Felis catus*) are considered the most likely common factor in the recent declines of mammals, including ngwayir, in the Upper Warren (Wayne et al 2017). Ngwayir abundance has also been positively associated with fox control (Wayne et al. 2006).
- Fire is also an important factor affecting ngwayir abundance in the Upper Warren (Wayne 2006, Wayne et al. 2006, 2022). Fire intensity has been repeatedly demonstrated to be a negative factor in the abundance of ngwayir, the effects of which can be significant for at least 20 years (Wayne et al. 2006, 2022).
- Forest fragmentation and timber harvesting are also negatively associated with ngwayir abundance (Wayne et al. 2006).

2.4 The ngwayir population within the Perup Sanctuary

- Ngwayir were frequently detected in the 1990s and 2000s during ad hoc and informal surveys in and around the Perup Sanctuary area prior to its construction in 2010. In the early 2000s ngwayir were abundant around the Perup Natures Guesthouse accommodation (adjacent to the Perup Sanctuary site) but began to decline in the mid-late 2000s to undetectable levels (Julia Wayne pers. com.).
- Perup Sanctuary was originally established in late 2010 to support an insurance population of the critically endangered woylie (Wayne et al. 2013; Yeatman and Wayne 2015).
- It was presumed that ngwayir were either absent or at very low (undetectable) numbers when the Perup Sanctuary was established, given that surveys immediately prior to and after the establishment of the Perup Sanctuary did not detect ngwayir.
- Twenty (20) ngwayir individuals (7 male,13 female, plus 10 pouch young) from the Busselton hospital development site were translocated to the Perup Sanctuary in August-September 2012. A subset of five males and six females, were collared with mortality-sensitive radio transmitters (Sirtrack equipped with a VHF core and brass band antenna) to monitor their survival and movements within the sanctuary. Of the 11 individuals collared, eight of the western ringtail possums from the Busselton cohort died (August 2012 – January 2013). The three remaining radio collars lost signal in April 2013, at the end of the monitoring period, and after failed attempts to recover the collars. However, there were a few confirmed records of radio-collared and uncollared but tagged ngwayir over the subsequent nine months (up to January 2014).

  -One of the three remaining collared animals were sighted on 3/12/13 during spotlighting (capture was attempted but unsuccessful).

-Through remote sensor cameras, a collared animal was detected on 29/6/13 and another on 24/1/2014 (approximately 900m apart) and an uncollared but tagged mother and young (sanctuary-born) were detected on 19/7/13.

- Eighteen (18) ngwayir individuals from across the Upper Warren were translocated to the Perup Sanctuary between 21/3/2016 and 26/4/2017. Four males and three females were radio-collared to monitor their survival and movements within the sanctuary. Of the seven individuals radio-collared from the Upper Warren cohort, one died (September 2016, 5 months after being released), one removed its collar (left in a tree hollow) and a third collar was unable to be retrieved from a tree hollow where it had gone into mortality mode. The remaining four collars were removed from the animals (alive) between 370 and 551 days after their initial release.
- The Busselton and the Upper Warren cohorts were released at different points within the Perup Sanctuary but within close proximity of each other and all within the vicinity of the creek line north of where it is intersected by Alf Road. Radio- tracking was conducted both during the day and at night to estimate the day and night refuges.

2.4.1 Overview of past possum survey and monitoring in Perup Sanctuary

Science surveys

Vehicle based spotlight surveys were conducted (2010 – 2013 & 2015) using similar methodology as the Kingston spotlight program (BCS Science Project Plan 2012-038; Wayne et al. 2005): 10.9 km transect (Figure 1), three repeat surveys per Spring or Autumn season (four repeat surveys in Autumn 2015), involving 2 observers located on a purpose-built seated observation platform mounted to the top of a 4WD vehicle roof rack, using handheld spotlights (100watt white light, Lightforce), travelling approximately 5 km per hour (A. Wayne unpublished data; Barrett 2016). No ngwayir were detected prior to the translocation of animals from Busselton in 2012 (Table 1). Seven detections of at least five individuals were recorded three months after their release, but no ngwayir were detected a further 3-4 months later, in autumn 2013 (Table 1). Two ngwayir were also detected in Autumn 2015 (assumed to be of Busselton pedigree), prior to the translocation in 2016-2017 of ngwayir sourced from the Upper Warren.

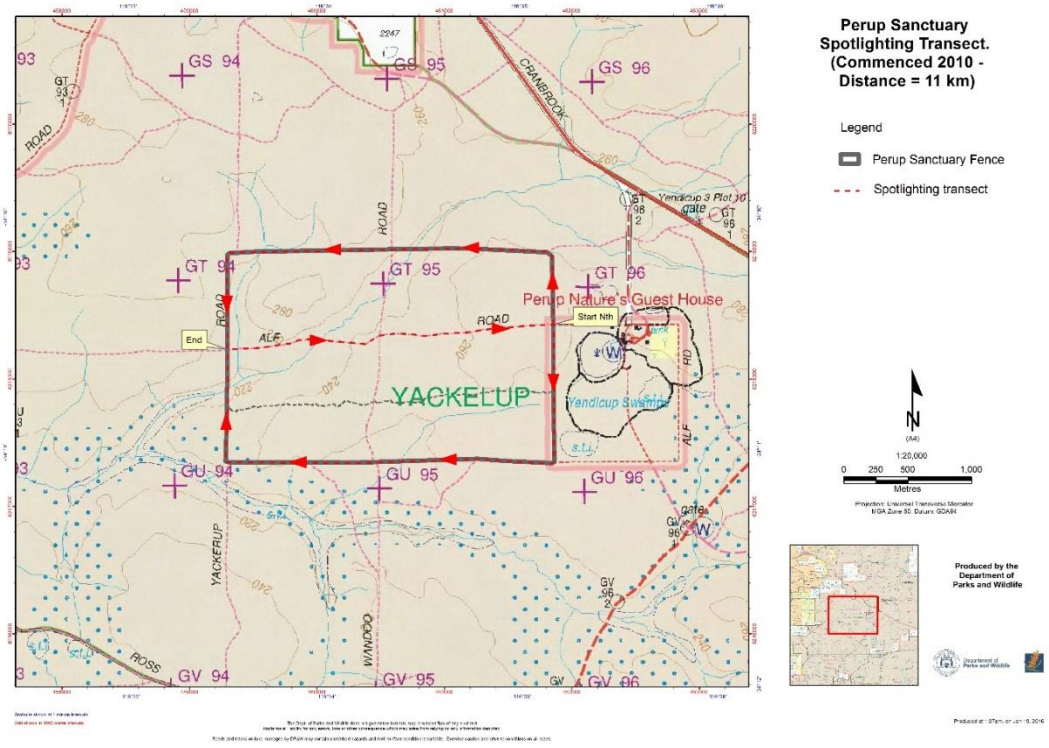

Figure 1. Location of the vehicle-based spotlight survey transect in the Perup Sanctuary (2010 – 2013 and 2015).

Table 1. Summary of ngwayir and koomal detections during the vehicle-based spotlight surveys in the Perup Sanctuary (2010-2015).

	Ngwayir	Koomal
1/10/2010	0	14
2/10/2010	0	8
3/10/2010	0	13
28/03/2011	0	6
18/04/2011	0	8
20/04/2011	0	13
21/11/2011	0	5
23/11/2011	0	11
29/11/2011	0	7
7/03/2012	0	5
28/03/2012	0	5
10/04/2012	0	6
3/12/2012	1	9
5/12/2012	1	2
7/12/2012	5	8
27/03/2013	0	7
3/04/2013	0	11
4/04/2013	0	10
24/3/2015	0	26
25/3/2015	0	12
26/3/2015	0	16
28/4/2015	2	13
Total	**9**	**215**

Barrett surveys (Honours project)

Pedestrian-based spotlight surveys by two observers over four nights in Autumn 2015 focused on creek line areas within the sanctuary to optimise the likelihood of encountering possums. Surveys began approximately 30-45 minutes after sunset and lasted approximately four hours (limited by the battery life of spotlights). Observers used the same handheld spotlights used during the vehicle-based surveys (Lightforce with 100-watt, white light, connected to a 12-volt motorcycle battery carried in a backpack) and walked approximately 50m apart in parallel lines to maximise the chance of detection (Barrett, 2016). Only two ngwayir were detected during these surveys (Table 2).

Table 2. Count of ngwayir and koomal recorded in Perup Sanctuary from pedestrian -based spotlight surveys (April 2015). Source: Barrett (2016).

	Ngwayir	**Koomal**
31/03/2015	2	8
1/04/2015	0	5
2/04/2015	0	6
3/04/2015	0	4
Total	**2**	**23**

Density estimates of koomal in the Perup Sanctuary in March-April 2015 varied between 0.37 ha^{-1} (0.23 – 0.61 95% CI; i.e., 156 (97 – 258 individuals)) based on distance sampling modelling using vehicle-based spotlight data and 1.15 ha^{-1} (0.76 – 1.74 95% CI; i.e. 486 (321 – 736 individuals)) using Spatial Explicit Capture Recapture modelling using cage trap data (Barrett 2016).

District surveys

Spotlighting:

Ngwayir detected during nocturnal activities (e.g., radio-telemetry and non-systematic spotlighting) conducted by Donnelly District also confirmed that some individuals were present in the Perup Sanctuary at least one year after the Busselton animals were released in August – September 2012. There were more records of ngwayir in the year after the release of ngwayir sourced across the Upper Warren region (March- 2016 – April 2017) (Table 3).

Table 3. Summary of ngwayir opportunistically detected during nocturnal activities conducted by the Donnelly District in the Perup Sanctuary

Date	No. tagged Adult	No. untagged Adult	No. untagged Subadult
3/12/2013	3	1	2
4/12/2013	0	1	1
30/04/2014	0	0	0
1/05/2014	0	0	0
21/11/2016	0	1	0
24/11/2016	0	6	0
3/04/2017	0	3	1
9/05/2017	0	2	0
5/09/2017	0	1	0
7/09/2017	0	2	0
30/10/2017	1	4	1
31/10/2017	0	3	2
15/11/2018	0	2	0

Remote Sensor Camera trapping:

Routine remote sensor camera trapping has been conducted within the Perup Sanctuary for the main purpose of introduced predator incursion surveillance. Single or paired cameras have been used at 14 locations around the internal perimeter of the Perup Sanctuary (Figure 2), generally focussing along the internal fence line. This data crudely indicates that ngwayir from Busselton persisted at low numbers, but numbers have tended to increase since the release of ngwayir from across the Upper Warren in 2016-2017 (Table 4). Caution is needed in interpreting this data any further given that
1) the survey effort varied to some extent over time with some reduction in recent years (not quantified here),
2) the frequency of camera checks decreased over time (2013-June 2015 was twice weekly, July 2015 -Dec 2017 was weekly and Jan 2018 to current was fortnightly), and,
3) the data only quantifies the number of cameras that detected at least one ngwayir within a given monitoring period.

A 300m x 300m grid of 54 remote sensor cameras were deployed (June – September 2013) in the Perup Sanctuary for the purposes of monitoring woylies. There were three incidental detections of ngwayir during this time: a collared animal on 29/6/13, an uncollared but tagged mother and young (sanctuary-born) on 19/7/13, and an uncollared individual (not sure if tagged) on 21/8/13.

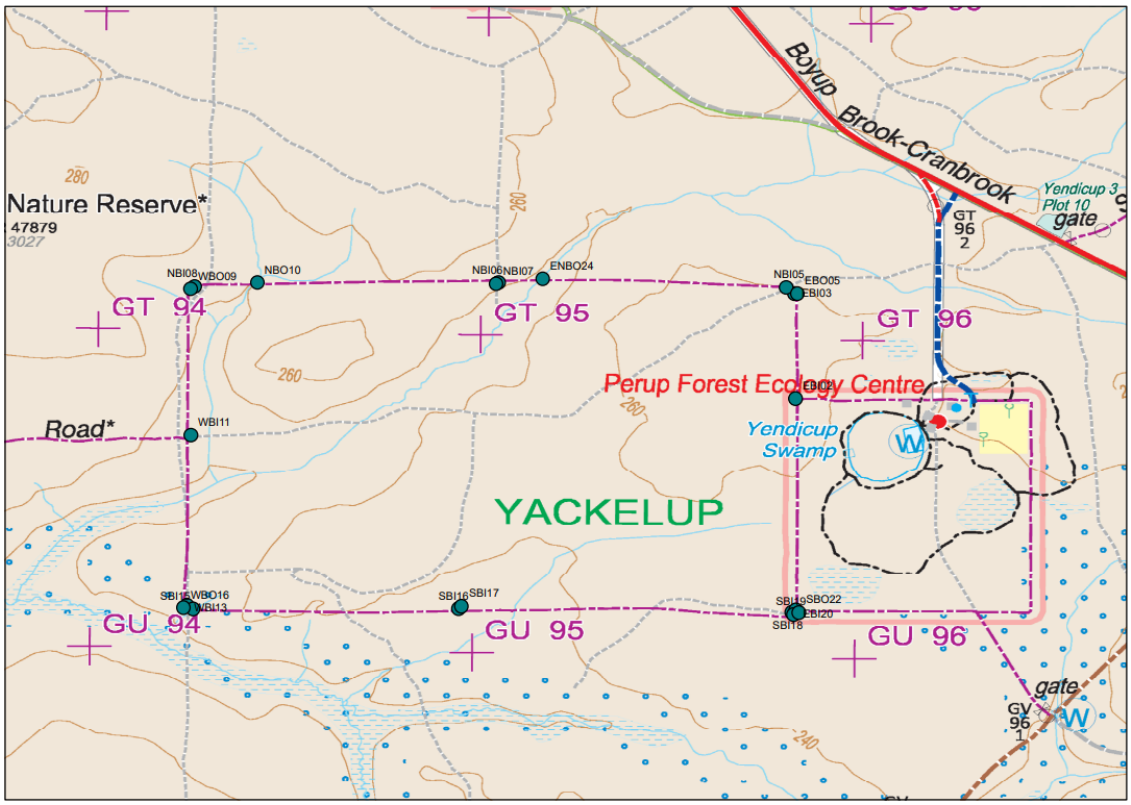

Figure 2. Map showing the location of regular remote sensor camera monitoring points.

Table 4. Summary of ngwayir during predator incursion monitoring conducted by the Donnelly District using remote sensor camera traps in the Perup Sanctuary.

Note: detection rate is the sum of the number of monitoring locations (14) that detected at least one ngwayir within a given camera check period and summed over a calendar year. Note the year 2022 includes data for only 11 months.
** = 1 individual was detected with radio-collar and ear tags (i.e., Busselton founder).*

Year	Detection rate
2013	6
2014	2*
2015	1
2016	17
2017	7
2018	20
2019	14
2020	20
2021	25
2022	37

3 Methods

3.1 Study area

The Perup Sanctuary is located 40 km east of Manjimup in the Tone-Perup Nature Reserve, in the Upper Warren region, southwestern Australia. Adjacent to the Perup Nature's Guesthouse accommodation and education facility, the Perup Sanctuary was established in 2010 and has an introduced predator exclosure fence encompassing 423 ha (Wayne et al. 2013). Part of the Southern Jarrah Forest IBRA subregion (JAF02), the forests and woodlands of the area are dominated by jarrah (*Eucalyptus marginata*), marri (*Corymbia calophylla*) and wandoo (*Eucalyptus wandoo*), with some yate (*Eucalyptus decipiens*) and flooded gum (*Eucalyptus rudis*) (Figure 3). Riparian vegetation within the sanctuary include thickets of *Melaleuca viminea*. Thickets of heartleaf (*Gastrolobium bilobum*) are also prominent (Department of Environment and Conservation 2012). The area experiences a Mediterranean-type climate (with warm dry summers and cool wet winters) with a long-term annual average rainfall of around 700 mm.

Foxes (*Vulpes vulpes*), cats (*Felis catus*), emus (*Dromaius novaehollandiae*), and chuditch (*Dasyurus geoffroii*) were removed or confirmed absent from the Perup Sanctuary at the time of establishment. While most were herded out, a few yongka (western grey kangaroo, *Macropus fuliginosus*) and one kwara (western brush wallaby, *Notamacropus irma*) are known to remain within. Other non-volant native mammals recorded in the Perup Sanctuary include woylie (*Bettongia penicillata*), ngwayir, koomal, quenda (*Isoodon fusciventor*), tammar wallaby (*Notamacropus eugenii*), numbat (*Myrmecobius fasciatus*), wambenger (*Phascogale tapoatafa wambenger*), dunnart (*Sminthopsis spp.*), mundarda (western pygmy possum, *Cercartetus concinnus*), and mardo (*Antechinus flavipes*). Some removal of yongka, kwara and koomal individuals remains ongoing.

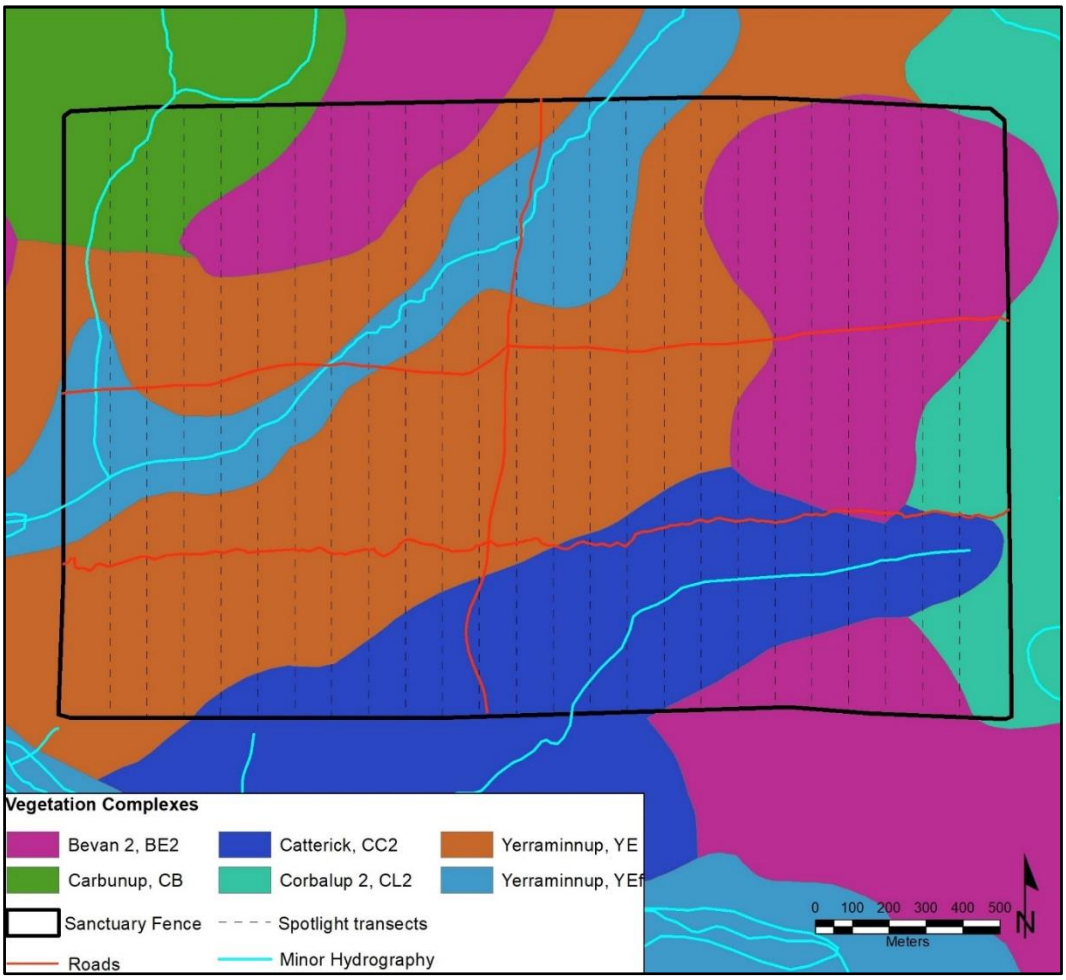

Figure 3. The main vegetation associations in the Perup Sanctuary.

3.2 Spotlight survey method

Line transect distance sampling surveys were undertaken on 7th – 9th November 2022 using methods described in Teale and Potts (2020) and Wayne et al. (2022a & b). Twenty-four transects (average 1660 m each) running north-south were spaced 100 m apart within the Perup Sanctuary, following the established grid markers (metal fence droppers) spaced 100 m apart (Figure 4). Surveys began approximately 1 hour after sunrise and finished before sunrise.

Each transect was surveyed by a single observer, following the transect using a GPS and walking quietly at approximately 1 km per hour. Three observers co-ordinated the concurrent survey of adjacent transects to reduce the chances of the same possum individuals having enough time to travel and be recorded on separate transects. Animals were searched for using a high-powered head torch (Led Lenser XEO 19R or H19R Core models). For each animal observation the following information was recorded; animal location (using a GPS), species (principally medium-sized and larger mammals and some larger birds), time, number of individual animals, animal position (e.g., ground, tree), tree species and size class (based on diameter at breast height over bark (DBH: 1.3m above ground), and other

information about the animals (e.g., adult / independent animal, female with joey on back, female with joey at heel). Data validation included checking that the same possum individual was not recorded more than once from adjacent transects (i.e., the location of possums were not close to other records made from adjacent transects).

3.3 Hand capture

Spotlighters assessed whether the ngwayir individuals they detected were feasible for hand capture (e.g., within 5 m of the ground and in an isolated shrub or tree with limited connectivity for escape). If the animal was within easy reach and it was safe to do so, the spotlighter would immediately capture the individuals, having a handling bag at the ready. However, spotlighters generally contacted a dedicated capture team of six to eight people via UHF and VHF radio to relay the location of candidate ngwayir. To avoid the disturbance of animals along the transects, the capture team followed behind the spotlighters, maintaining a suitable distance (usually >100m) and remained only in areas that had already been surveyed by the spotlighters. The capture team used pruning loppers and ropes to manipulate the vegetation to aid in the capture of ngwayir using nets and/or by hand. Captured animals were placed into handling bags and immediately processed on site. Basic biometrics (weight, head length, sex, breeding condition, gross signs of health and body condition) were recorded and small biopsies of ear tissue for genetic analysis were collected. Captured animals were released at point of capture immediately upon completion of processing.

3.4 Demographic analysis

Distance sampling analysis (Buckland *et al.* 2001) was undertaken using the 'Distance' package (v. 1.0.4, Miller *et al.* 2019) in R (v. 4.1.2, R Core Team, 2022). The perpendicular distance of the possum's location from the transect were used to estimate the Probability Detection Function (i.e., the probability of detecting a possum, given it is *x* m from the transect line). Variation in the probability detection function caused by observers (factor covariate: observer) were explored.

Options available for the key detection functions include hazard rate ('hz'), half normal ('hn') and uniform ('unif'). The key detection function was selected based on Akaike Information Criteria (AIC, i.e., model with the lowest AIC, Buckland *et al.* 1997), with a default selection for a cosine-adjustment term. Additional adjustment terms were explored (i.e., 'poly'), and inference was based on the model with the lowest AIC. Only the final model is presented here.

3.5 Genetics

The tissue samples were immediately stored in 70% ethanol. DNA extraction, sequencing and analysis will be completed in early 2023.

4 Results

4.1 Survey results

Three observers walked 24 separate line transects totalling 39.6 km (Table 5 & 6). There was a total of 126 ngwayir individuals detected in 94 events (Table 7, Figure 4). In 28 of these events two ngwayir were detected and on four occasions three individuals were together. Of the 217 koomal individuals detected in 174 events (Table 7, Figure 5), there were 39 occasions when a pair of koomal were detected and two occasions when three individuals were detected together. Exploratory analyses revealed no significant differences in efficacy of detection possums between observers (Figure 6). The histograms of the detection distances for ngwayir and koomal are provided in Figure 7.

Preliminary modelling used a truncation distance (*w*) of 45 m. That is, observations greater than 45 m were discarded from the analysis, representing about 5% and 6% of the total ngwayir and koomal observations, respectively. This value met a rough rule-of-thumb that the top 5% of distance observations be truncated. However, this does not meet the recommendation for the estimated detection probability at the truncation distance to be 0.15 (i.e., $\hat{g}(w) \approx 0.15$, Buckland et a. 2001, p. 151). This is also less than the 55m truncation distance used by Teale and Potts (2020) on ngwayir detection data from the Upper Warren but is the same as the truncation distance used for the ngwayir survey of the Upper Warren hotspot by Wayne et al. (2022a). Unlike these two studies that found the best distance sampling models used a half-normal detection function, a hazard reduction detection function was best for the Perup Sanctuary data (Figure 8). A half normal detection function was the best for the koomal data.

The preliminary distance sampling model (Buckland *et al.* 2001) estimated the population size in the Perup Sanctuary to be 155 ngwayir individuals (127.5 - 190.3, 95% Confidence Interval) and 350 koomal individuals (95% CI 272.6 - 451.2).

Table 5. Summary of spotlight surveys conducted in the Perup Sanctuary 2022.

	2022
Number of observers	3
Number of transects surveyed	24
Transect spacing (m)	100
Total length surveyed (km)	39.6
DS Truncation distance (m)	45
Total area surveyed (ha)	356
Survey region (ha)	423
% of survey region actually surveyed	84%

Table 6. Summary of which observers surveyed what transects, the total distance walked by each observer and the number of detection events for the two species.

Observer	Transects Surveyed	Total distance (km)	Ngwayir detection events	Koomal detection events
Adrian Barrett	4, 7,10,13,16,19, 22, 25	13.3	29 (40)	54 (66)
Adrian Wayne	3, 6, 9, 12, 15, 18, 21, 24	13.3	26 (38)	71 (93)
Marika Maxwell	2, 5, 8, 11, 14, 17, 20, 23	13.3	39 (52)	49 (58)
Total		39.6	94 (126)	174 (217)

Table 7. Summary of species detected during spotlight surveys on transect in the Perup Sanctuary, November 2022.

Species	Number of Detection events	Total number of individuals
Ngwayir	94	126
Koomal	174	217
Woylie	30	34
Western grey kangaroo	2	2
Wambenger	3	3
Quenda	1	1
Tammar wallaby	2	2

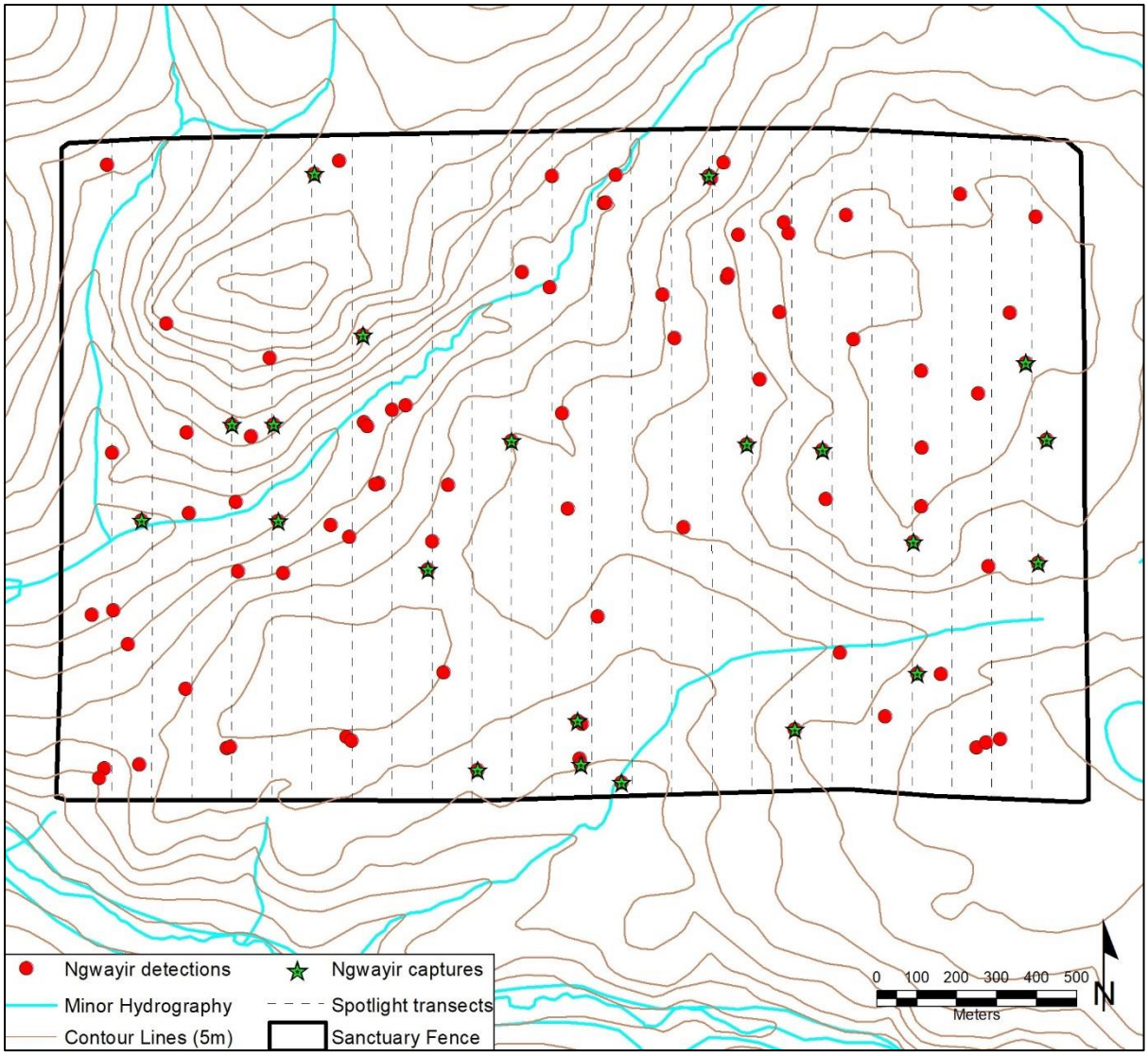

Figure 4. Independent detections of ngwayir on transect during distance sampling spotlight surveys conducted in Perup Sanctuary (November 2022).

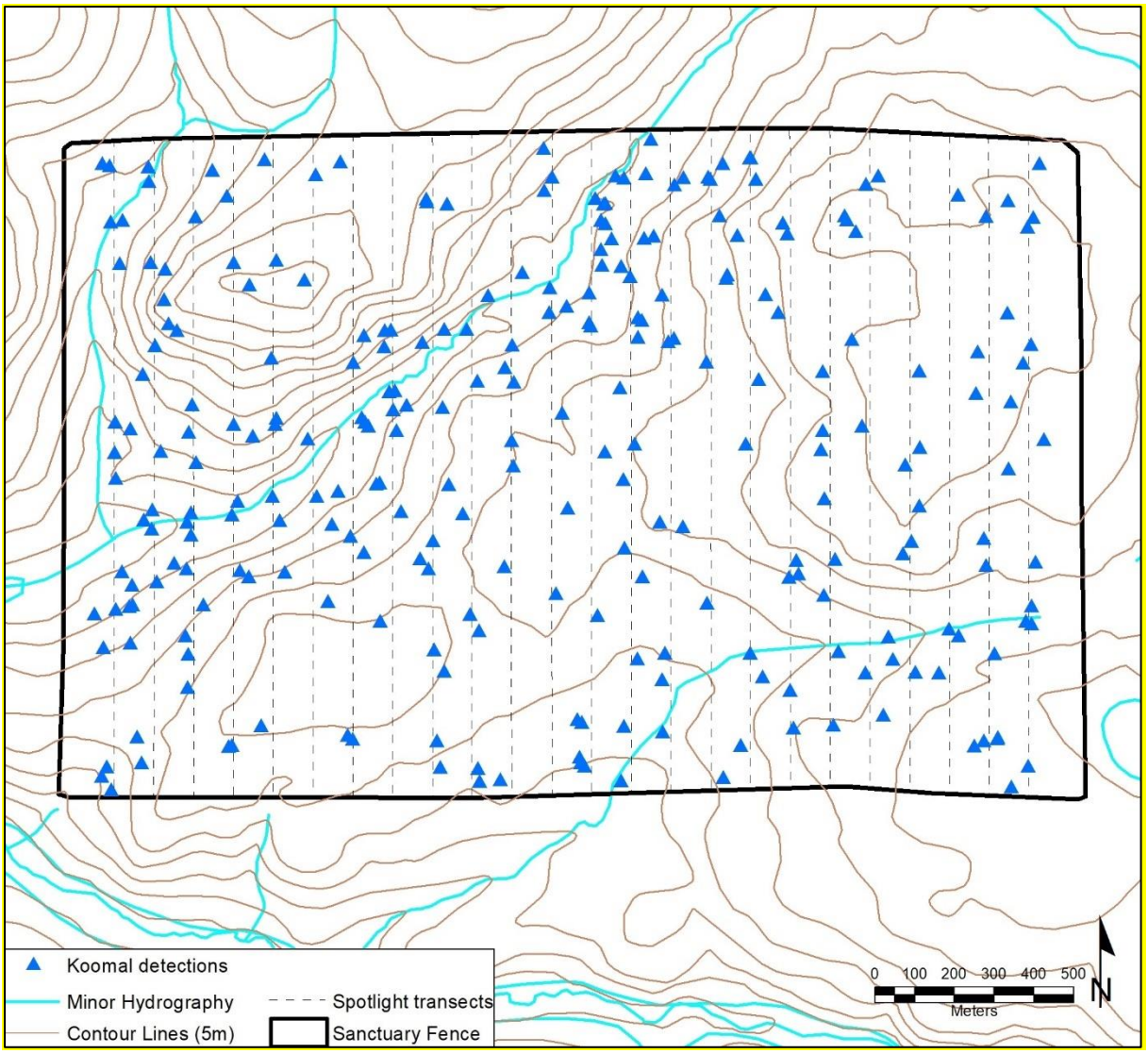

Figure 5. Independent detections of koomal on transect during distance sampling spotlight surveys conducted in Perup Sanctuary (November 2022).

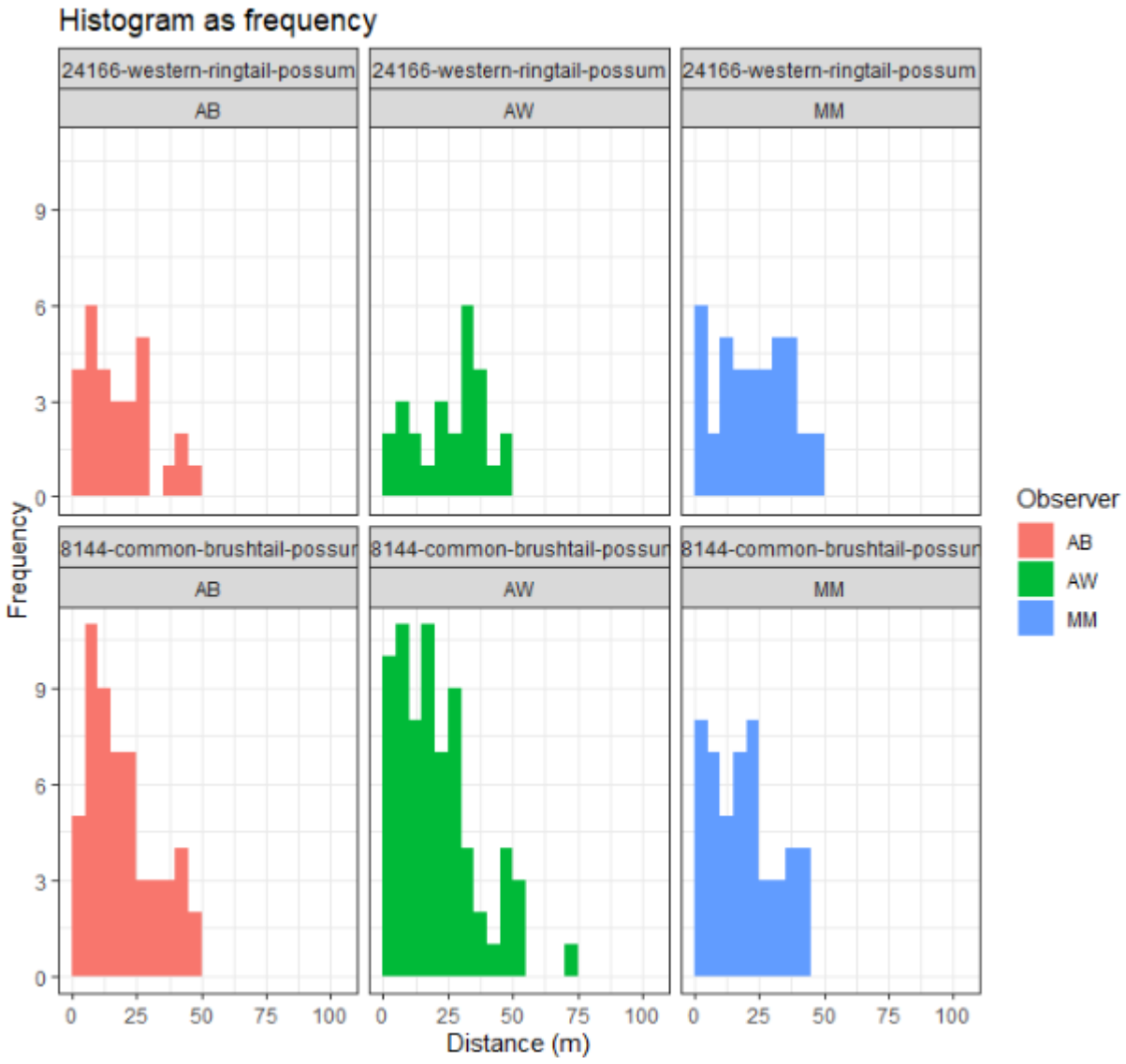

Figure 6. Frequency histograms of detection distances for both possum species and by each spotlight observer, Perup Sanctuary (November 2022).

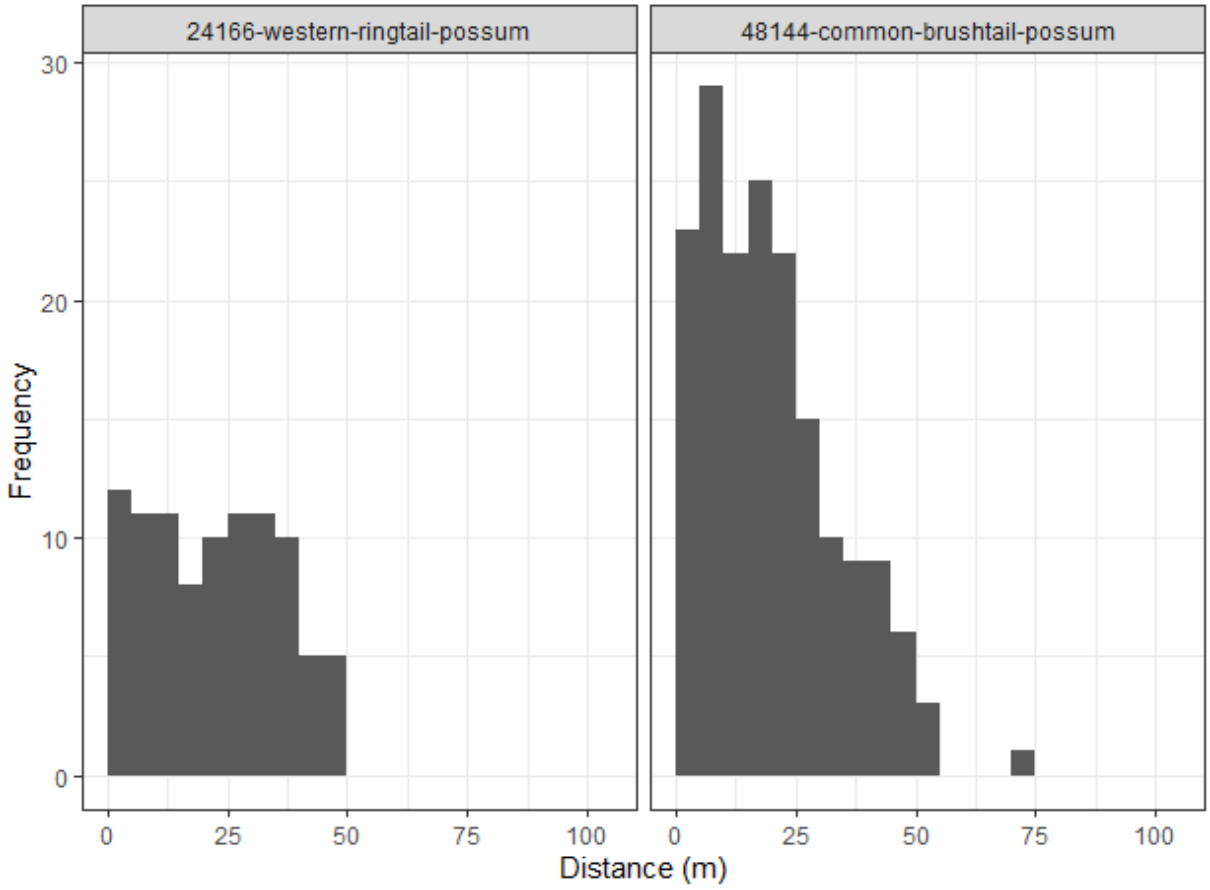

Figure 7. Histograms of detection distances of ngwayir and koomal in the Perup Sanctuary (November 2022) from the three observers combined.

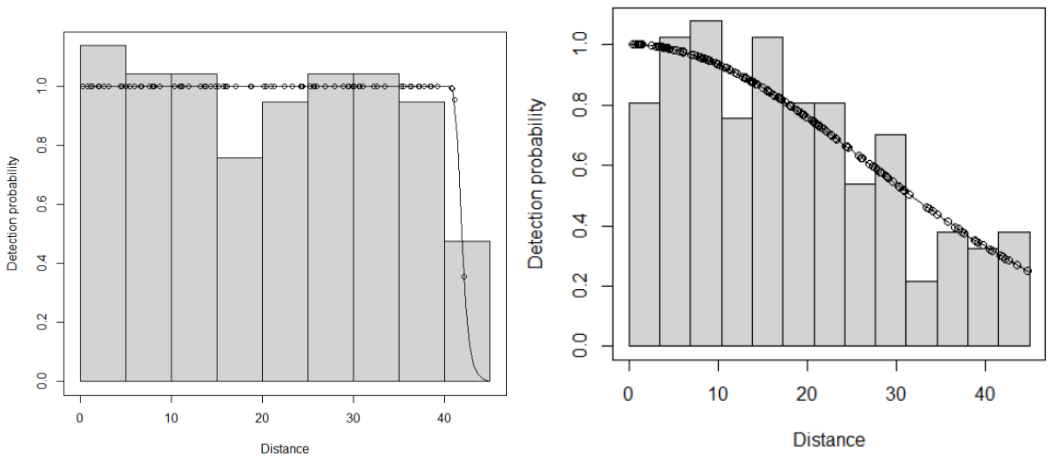

Figure 8 Fitted detection curve in relation to distance from transect (m), with truncation distance of 45 m, for ngwayir (left) and koomal (right)

4.1.1 Possum habitat use

Most ngwayir and koomal were observed in arboreal locations.

About two thirds (68%) of ngwayir were detected in trees with less than 40 cm DBH diameter at breast height over bark (DBH, 1.3m above ground). The location of koomal differed, with 73% being in trees larger than 40 cm DBH (Table 8a). There was no major difference in the species of tree used by both possum species (Table 8b). However, there were differences between possum species in the height above ground at which they were observed: 67% of ngwayir were 10 m or less above ground and 65% of koomal were greater than 10 m above ground (Figure 9).

Table 8. Summary of the location of possums detected during the 2022 spotlight survey of the ngwayir hotspot in the Upper Warren.

a) Substrate structure

		Terrestrial	Arboreal				
Species	n	Ground / log	Shrub	Tree sapling (<15 cm d.)	Tree pole (15-40 cm d.)	Large tree (>40 cm d.)	Dead
Ngwayir	94	3.2	7.4	41.5	19.1	27.7	1.1
Koomal	171	4.7	1.8	6.4	12.3	73.1	1.8

b) Tree species. Note 'Other' includes *Eucalyptus rudis*, *E. decipiens*, *Banksia*, *Hakea*, *Melaleuca spp.*, *Xanthorrhoea preiseii*, and *Bossiaea linophylla*.

Species	n	Marri	Jarrah	Wandoo	Melaleuca	*Other
Ngwayir	90	38.9%	40.0%	5.6%	5.6%	10.0%
Koomal	166	31.3%	43.4%	17.5%	2.4%	5.4%

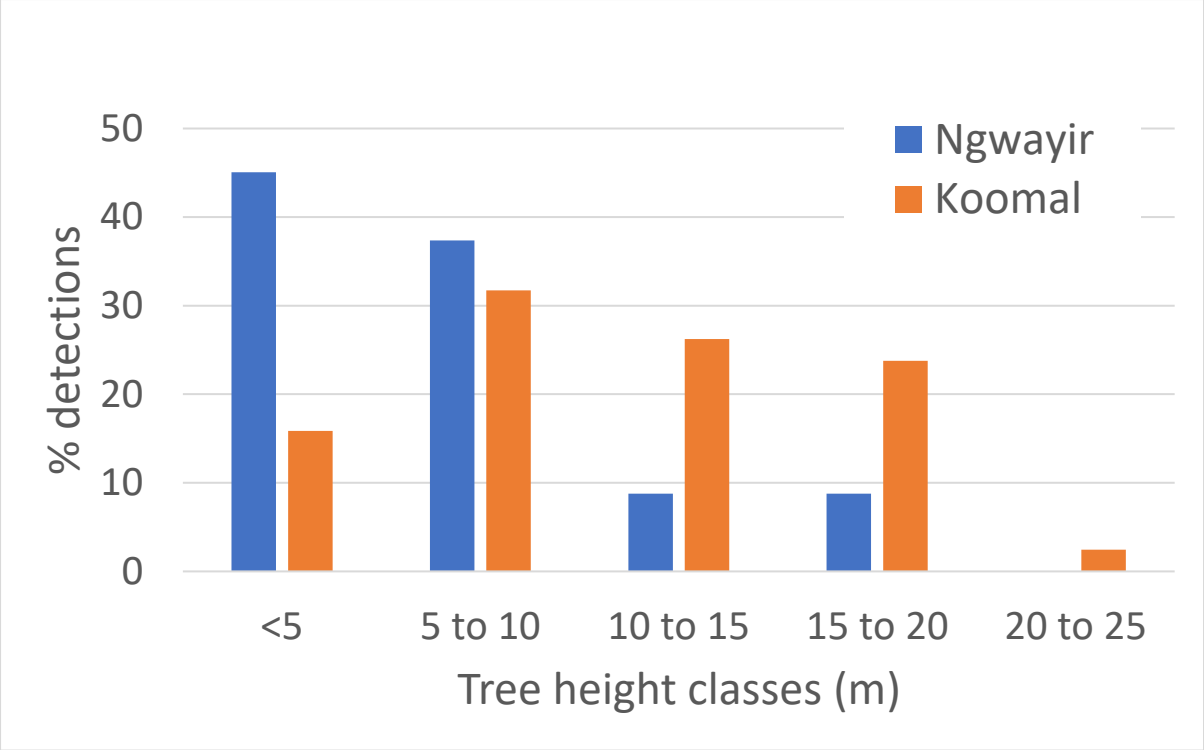

Figure 9. Height of ngwayir (n=92) and koomal (n=174) detected during spotlight surveys of Perup Sanctuary, 2022.

4.2 Ngwayir captures

Twenty-eight ngwayir were captured and tissue samples taken for DNA analysis (Figure 4, Table 9). Four of these were individuals considered to be dependent young of an adult mother that was also captured. All captured animals appeared in general good health with no obvious significant health issues. Adult weights ranged from 980g to 1330g, with body condition scores ranging from 3 (moderate condition) to 5 (very good condition). All captured adult females (6) had young at heal and two were also carrying a second small pouch young. All captured animals had very low ectoparasite loads.

Table 9. Summary demographic and biometric information of the 28 ngwayir hand-captured in the Perup Sanctuary (November 2022).

Left ear tag	Right ear tag	Sex	Age	Breeding	Wt. (g)	BC	Comments/Relationship
DL8312	DL8313	F	A	LacYP	1170	4	Mother of DL8326/27
DL8326	DL8327	F	J	U	530	4	Young of DL8312/13
DN8752	DL8314	M	A		1140	3	In same tree as DL8312/13. Previous capture 11/4/18 on Alf Grid.
DL8115	DL8116	M	A			4	
DL8117	DL8118	M	A			4	
DL8328	DL8329	M	A		1280	5	
DL8330	DL8331	M	A		1090	4	
DL8119	DL8120	F	A	B - 1 x 60mm		5	Mother of DL8121/22
DL8121	DL8122	F	J	U		3	Young of DL8119/20
DL8349	DL8350	M	A		1120	3	
DL8123	DL8124	F	A	B - 1 x 60mm		5	Sub-adult in tree with it - not captured.
DL8332	DL8333	M	A		1080	3	
DL8334	-	M	S		780	3	only tagged 1 ear.
DL8125	DL8173	F	A	LacYP		3	Mother of DL8126/DL8127
DL8126	DL8127	M	J		450	4	Young of DL8125/DL8173
DL8336	DL8337	F	A	LacYP	1240	4	Mother of DL8338/39
DL8338	DL8339	M	J		520	3	Young of DL8336/37
DL8128	DL8129	M	A		1190	3	
DL8149	DL8150	M	A		1020	4	
DL8130	DL8131	M	S		1270	4	small testes
-	-	F	J	U	370	4	Young of DL8132/8133 - too small to tag
DL8132	DL8133	F	A	LacYP	1070	3	Mother of animal above (22DN71R)
DL8134	DL8135	M	A		1030	3	
DL8136	DL8137	M	A		1190	3	
DL8138	DL8139	M	A		1090	3	
DL8140	DL8141	M	A		980	4	
-	-	F	J		520	4	Was in tree with mother - not captured.
DL8142	DL8143	M	A		1330	5	

Age: A=adult, S=subadult (independent but sexually immature), J=juvenile (dependent)

Breeding: LacYP = Lactating with young at heal present, U = undeveloped pouch (subadult), B= both young at heal and suckling pouch young present (crown-rump length measurement provided in millimeters)

BC= Body Condition (1=very poor, 2=poor, 3=moderate, 4=good, 5=very good)

5 Conclusions

This progress report demonstrates that the field program associated with the project has successfully collected data and samples to address the project aims. The results presented here are preliminary and subject to change as data management and analysis continues. The final report is planned to be completed in June 2023.

6 Photo Evidence

Figure 10: Spotlighters that conducted the pedestrian-based spotlight surveys in the Perup Sanctuary, November 2022.

Figure 11: Catching team, November 2022

Figure 12: Captured ngwayir being processed

Figure 13: Ngwayir being released

Figure 14. Pair of ngwayir being released

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