GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

A survey of ngwayir (western ringtail possum) in the Upper Warren, Western Australia, to inform a potential translocation to the Perup Sanctuary

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A survey of ngwayir (western ringtail possum) in the Upper Warren, Western Australia, to inform a potential translocation to the Perup Sanctuary

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June 2022

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This document is available in alternative formats on request.

Cover image: ngwayir in *Banksia grandis* (Photo by Adrian Wayne)

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Acknowledgments

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Summary

The ngwayir (western ringtail possum, *Pseudocheirus occidentalis*) is currently listed as *Critically Endangered* under the Australian Government's *Environment Protection and Biodiversity Conservation (EPBC) Act 1999.* A survey to determine the current spatial distribution and abundance of ngwayir (Western Ringtail Possum, *Pseudocheirus occidentalis*) within the population's 'hotspot' in the Upper Warren region was conducted between January and April 2022. Pedestrian-based spotlight surveys along 111 transects totalling 371.5 km resulted in a total of 438 ngwayir individuals being detected. A distance sampling model estimated the population size to be 8,341 individuals (7068 – 9842 95% Confidence Interval) across 38,349 ha. This is similar to a population estimate of 8,423 individuals (5,472 – 12,966, 95% CI), across a larger portion of the Upper Warren region (95,142 ha), based on survey using the same methods conducted in 2019. Notwithstanding the possibility of population change during the 3-year period between surveys, these results suggest that the vast majority of the extant ngwayir population is within the so called 'hotspot'. These results can be used to inform conservation and management within the area and can inform an assessment of the merits and feasibility of sourcing ngwayir for translocation to establish and maintain insurance populations in feral free enclosures.

1 Background

The purpose of this survey was to determine the current spatial distribution and abundance of ngwayir (Western Ringtail Possum, *Pseudocheirus occidentalis*) within the population's 'hotspot' in the Upper Warren region. The results of this survey will be compared to the results of a larger-scale survey conducted in 2019 (Teale and Potts 2020). The results from both surveys will be used to inform an assessment of the status of the ngwayir population in the region. This will provide important context for the ongoing conservation and management of this population and the insurance population in the Perup Sanctuary, which includes founders from both the Upper Warren and Busselton urban area. More specifically the results of this survey will provide an indication of appropriate potential source sites and help inform a determination of safe harvest numbers for a possible translocation for the purposes of genetic augmentation from the wild to the Perup Sanctuary.

2 Methods

2.1 Study area

The Upper Warren refers to the river catchments of the Wilgarup, Yerraminup, Perup and Tone Rivers, all tributaries of the Warren River, in southwestern Australia. For practical purposes it is considered here as the DBCA-managed public lands within the DBCA Warren Region east of the Southwest Highway between Bridgetown, Manjimup and Quinninup, and north and west of Lake Muir (Figure 1). At about 177,000 hectares, this includes some contiguous areas of DBCA-managed land within the Blackwood River catchment and Donnelly River catchment. The area includes State Forest, the Tone-Perup Nature Reserve (56,000 ha), the provisionally named 'Greater Kingston' National Park (21,000 ha) and several other smaller reserves.

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*). The area is particularly important for the conservation of several native mammals including the *Critically Endangered* woylie (*Bettongia penicillata*) and ngwayir, the *Endangered* numbat (*Myrmecobius fasciatus*), the *Vulnerable* chuditch (*Dasyurus geoffroii*) and quokka (*Setonix brachyurus*), the *Conservation dependent* wambenger (*Phascogale tapoatafa wambenger*), and Priority 4 species including quenda (*Isoodon fusciventer*), tammar wallaby (*Notamacropus eugenii derbianus*), and kwara or western brush wallaby (*Notamacropus irma*). Several of these species, including ngwayir, and others such as dunnarts (*Sminthopsis* spp.) and mootit or bush rat (*Rattus fuscipes*) have undergone significant and sustained declines since the 1990s, while others, such as the koomal (southwestern subspecies of common brushtail possum, *Trichosurus vulpecula hypoleucus*) have increased (Wayne *et al.* 2015; Wayne *et al.* 2017). The introduced red fox (*Vulpes vulpes*) and cat (*Felis catus*) are a significant threat to many native mammals. Other introduced species in the area that are of management interest include pig (*Sus scrofa*), goat (*Capra hircus*) and red deer (*Cervus elaphus*).

Fox baiting for conservation purposes began in some areas in 1977 (Burrows and Christensen 2002). It became broadscale to cover most of the study area in 1996 as part of the Western Shield program (Wayne *et al.* 2017; Wyre 2004). Other major management activities in the region include prescribed burning (McCaw *et al.* 2005), timber harvesting (Wayne *et al.* 2006; Wayne *et al.* 2016 and references therein) and dieback hygiene (i.e. reducing the spread of the plant pathogen *Phytophthora cinnamomi*).

Land uses of the freehold land around the DBCA-managed lands in the Upper Warren are primarily agricultural (sheep, cattle, grain and oil crops), plantation forestry (blue gums and pine), viticultural (wine grapes), and horticultural (fruit tree orchards and vegetables).

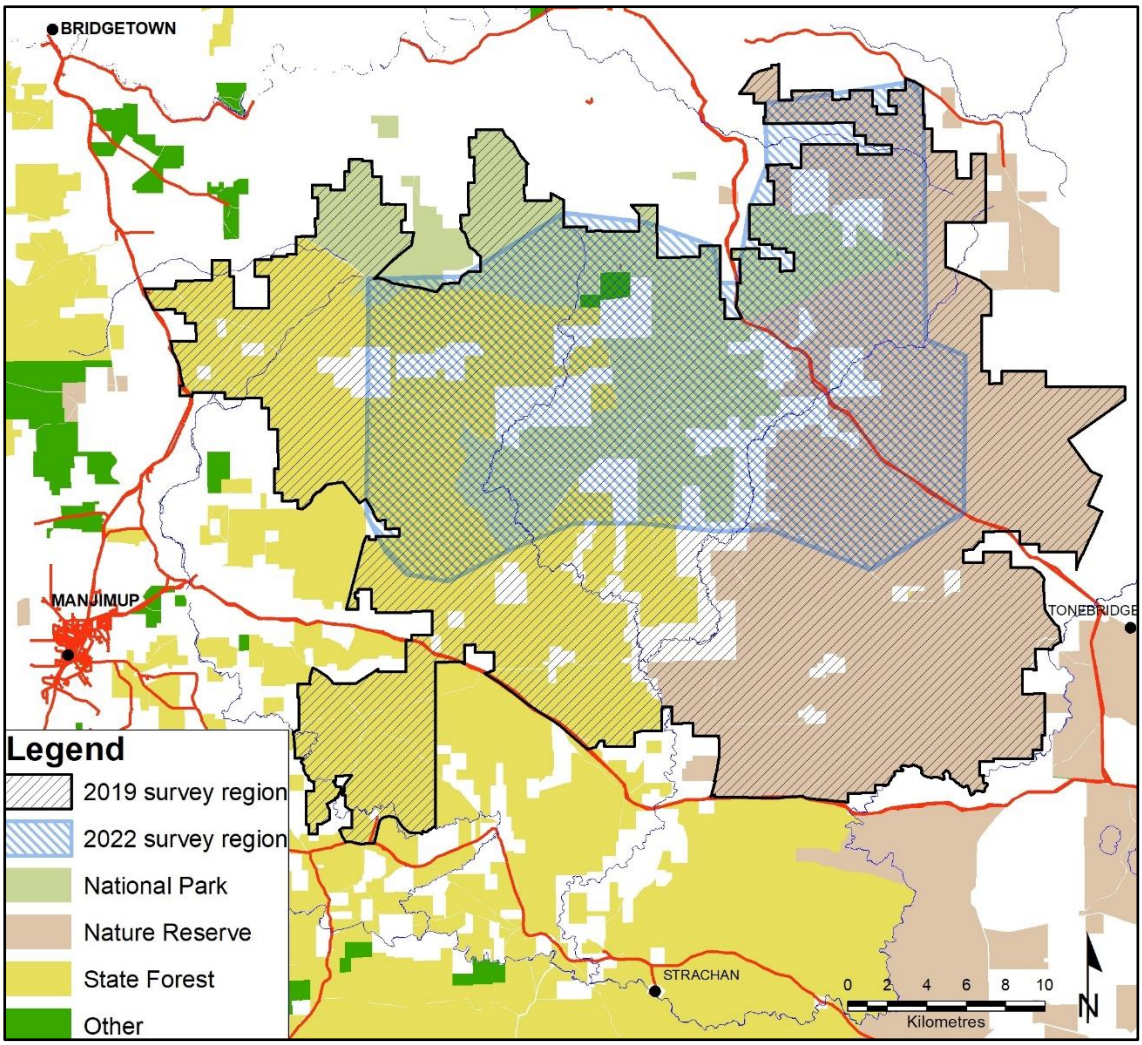

Figure 1. Ngwayir survey regions of 2019 (black forward diagonal hatching) and 2022 (blue and backward diagonal hatching), within the Upper Warren, Western Australia. Main sealed roads (red lines) and major hydrography (blue lines) are also depicted. Non-DBCA managed land (white areas) was not included in the surveys and is mostly freehold (private property) used for agriculture.

2.2 Survey methods

Line transect distance sampling surveys were undertaken in 2019 and 2022 using methods described in Teale and Potts (2020). Between February and March 2019, the surveys were undertaken by Biota Environmental Services on transects spaced 2.5 km apart on DBCA-managed land across the northern portion of the Upper Warren region (Figure 1 & 2). Between January and April 2022, the surveys were conducted by DBCA's Biodiversity and Conservation Science (BCS) on transects spaced 1 km apart within a smaller northern portion of the Upper Warren, focussing on the so called ngwayir 'hotspot' (Figure 1 & 3) - the area that had relatively high detection rates of ngwayir in the 2019 survey.

Each transect was surveyed by a single observer, following the transect using a GPS and walking quietly at approximately 1 km per hour. 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).

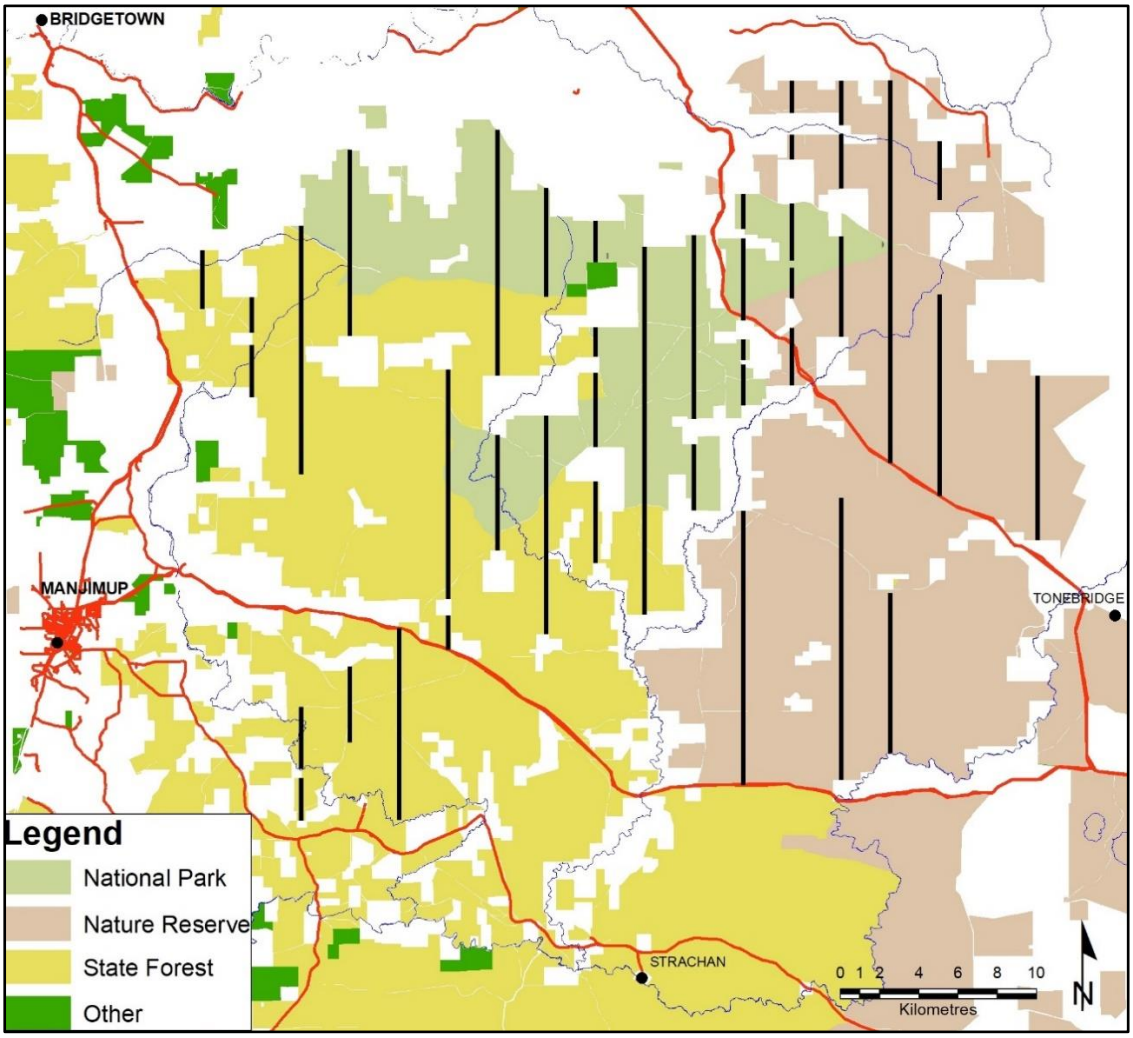

Figure 2. Spotlight transects (black parallel lines, running north-south, spaced 2.5 km apart), in the Upper Warren, surveyed in 2019. Main sealed roads (red lines) and major hydrography (blue lines) are also depicted. Non-DBCA managed land (white areas) was not included in the surveys and is mostly freehold (private property) used for agriculture.

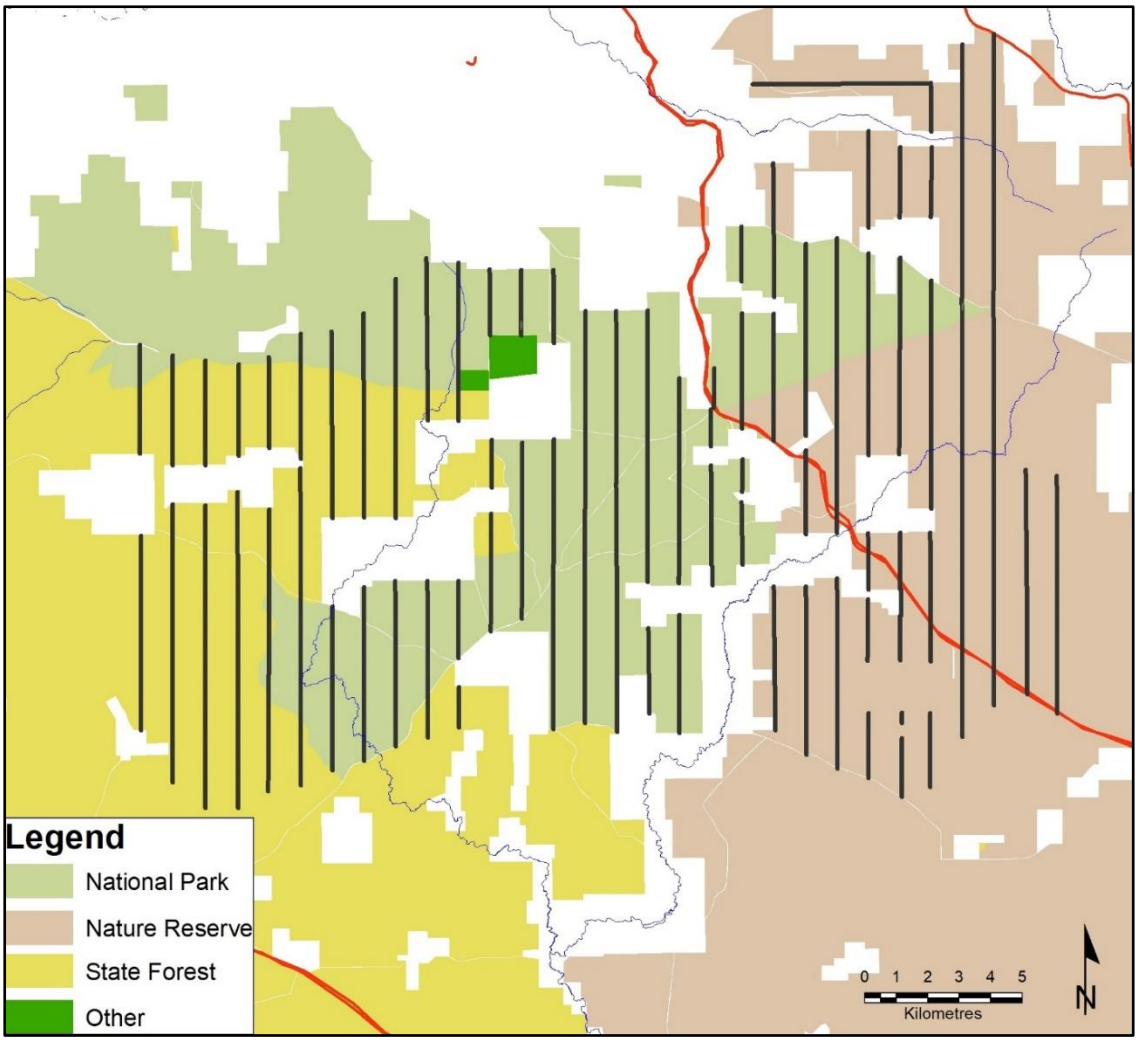

Figure 3. Spotlight transects (black parallel lines running north-south, most spaced 1 km apart), in the Upper Warren, surveyed in 2022. Main sealed roads (red lines) and major hydrography (blue lines) are also depicted. Non-DBCA managed land (white areas) was not included in the surveys and is mostly freehold (private property) used for agriculture. Note this is a subset of the area surveyed in 2019 but at a finer spatial scale.

2.3 Analyses

Data from the 2019 survey (Teale and Potts 2020), was kindly provided by the authors and data custodians at Biota Environmental Services (Biota). 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 data collected in 2022 were analysed separately. For both datasets, 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 for teach of the two datasets (2019 and 2022) is presented here.

3 Results

3.1 2019 survey results

Three observers walked 91 separate line transects totalling 251.4 km of length (Table 1 and 2). There was a total of 175 ngwayir individuals detected in 153 events (Figure 4). In 22 of these events two ngwayir were detected. Exploratory analyses revealed no significant differences in efficacy of detection possums between observers. The transects and locations of ngwayir detection events used in the analysis presented in this report are plotted in Figure 5 and a histogram of the detection distances are provided in Figure 6.

A truncation distance of 55 m was used for the 2019 distance sampling modelling conducted here. This resulted in about 8% of the total observations being discarded (i.e., 13 of the 153 detection events were at a distance > 55 m). This value exceeds a rough rule-of-thumb that the top 5% of distance observations be truncated, and the estimated detection probability at the truncation distance be 0.15 (i.e., $\hat{g}(w) \approx 0.15$, Buckland et a. 2001, p. 151). However, for consistency with the Biota (2020) report, 55 m was used. A half-normal detection function was used for the 2019 data (Figure 7).

The distance sampling model (Buckland *et al.* 2001) estimated the population size of the larger survey area (95,142 ha) in 2019 to be 8,223 individuals (5,472 – 12,966, 95% Confidence Interval).

Table 1. Comparative summary of spotlight surveys conducted in the Upper Warren in 2019 and 2022.

	2019	**2022**
Number of observers	3	6
Number of transects surveyed	91	111
Transect spacing (km)	2.5	1
Total length surveyed (km)	251.4	371.5
DS Truncation distance (m)	55	45
Total area surveyed (ha)	2,765	3,344
Survey region (ha)	95,142	38,349
% of survey region actually surveyed	3%	9%

Table 2. 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 (individuals)
Brandon	MJ_10, MJ_100, MJ_104A, MJ_105, MJ_106B, MJ_122, MJ_15, MJ_22, MJ_35A, MJ_38B, MJ_40B, MJ_41, MJ_44B, MJ_45B, MJ_47A, MJ_55B, MJ_67B, MJ_70, MJ_71, MJ_75, MJ_76B, MJ_77B, MJ_84, MJ_85B, MJ_86B, MJ_90B, MJ_91, MJ_93, MJ_94B, MJ_96A, MJ_97	76.5	25 (26)
Mikey	MJ_01B, MJ_03, MJ_04B, MJ_05, MJ_11, MJ_14, MJ_21, MJ_24, MJ_25, MJ_26A, MJ_33B, MJ_34, MJ_35B, MJ_38A, MJ_39, MJ_40A, MJ_44A, MJ_45A, MJ_46, MJ_47B, MJ_53B, MJ_54, MJ_55A, MJ_60, MJ_61B, MJ_65, MJ_66, MJ_68, MJ_69, MJ_74, MJ_76A, MJ_77A, MJ_85A, MJ_86A, MJ_89, MJ_90A	103.1	96 (113)
PK	MJ_01A, MJ_04A, MJ_06, MJ_09, MJ_104B, MJ_106A, MJ_107, MJ_12, MJ_121, MJ_26B, MJ_27, MJ_28, MJ_32, MJ_33A, MJ_52, MJ_53A, MJ_59, MJ_61A, MJ_94A, MJ_95, MJ_96B, MJ_99	62.1	32 (36)
Total		241.7	153 (175)

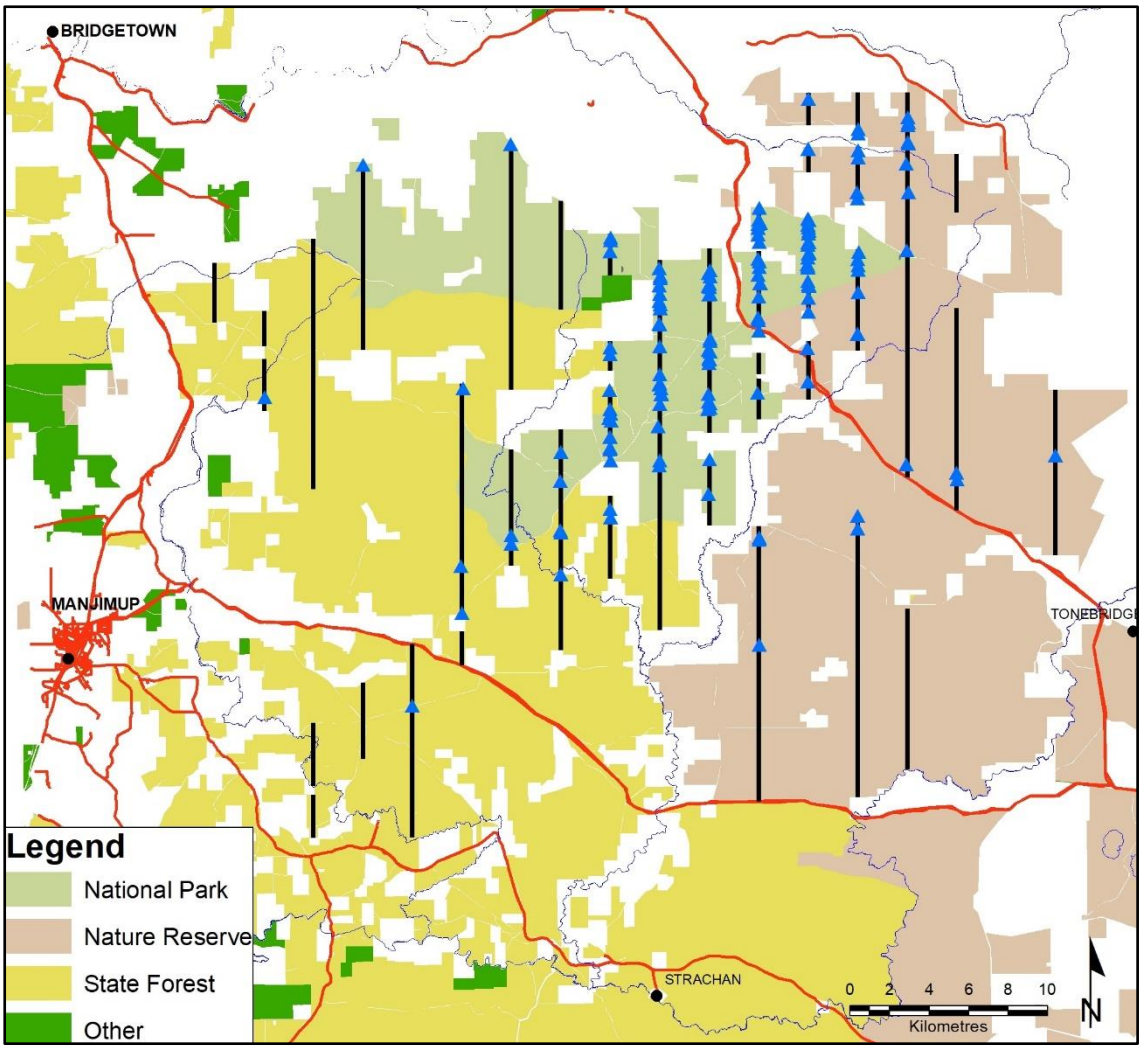

Figure 4. Independent sightings of ngwayir on transect during distance sampling spotlight surveys conducted in 2019 during the regional surveys within the Upper Warren. Main sealed roads (red lines) and major hydrography (blue lines) are also depicted. Non-DBCA managed land (white areas) was not included in the surveys and is mostly freehold (private property) used for agriculture. Note this is a larger area than was surveyed in 2022.

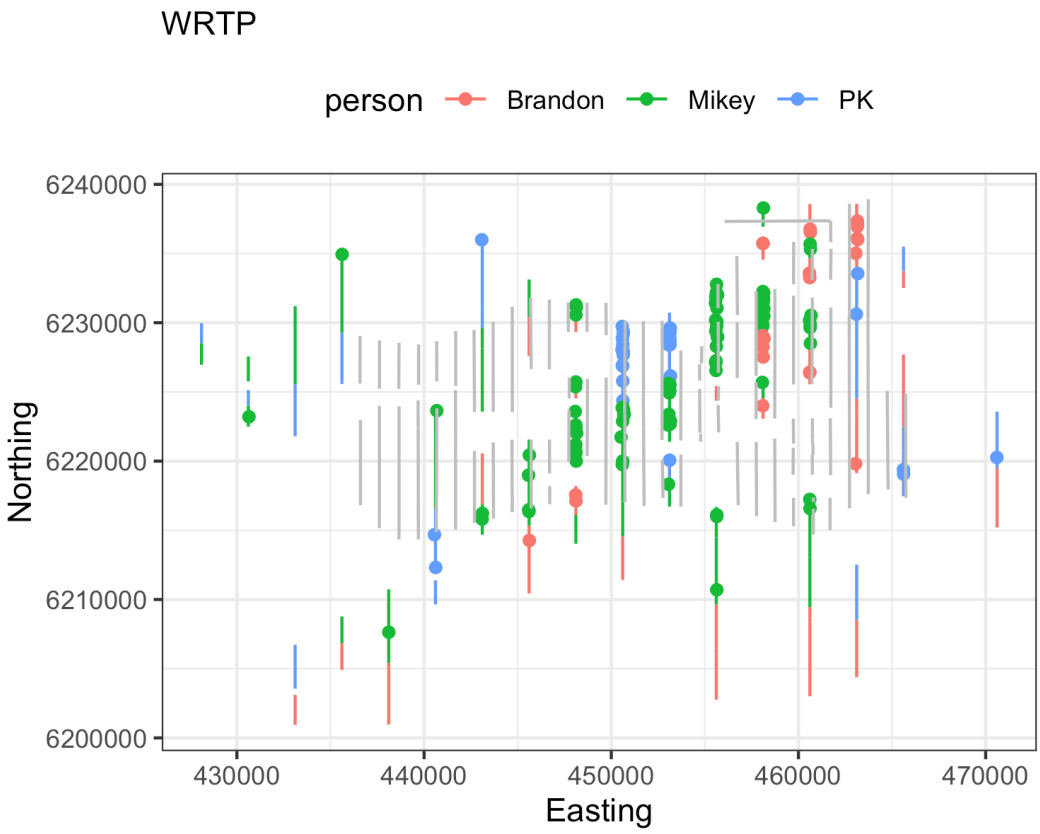

Figure 5. Location of transects and detection events for ngwayir in 2019, colour coded by observer. For reference, transect lines from 2022 are overlaid in light grey.

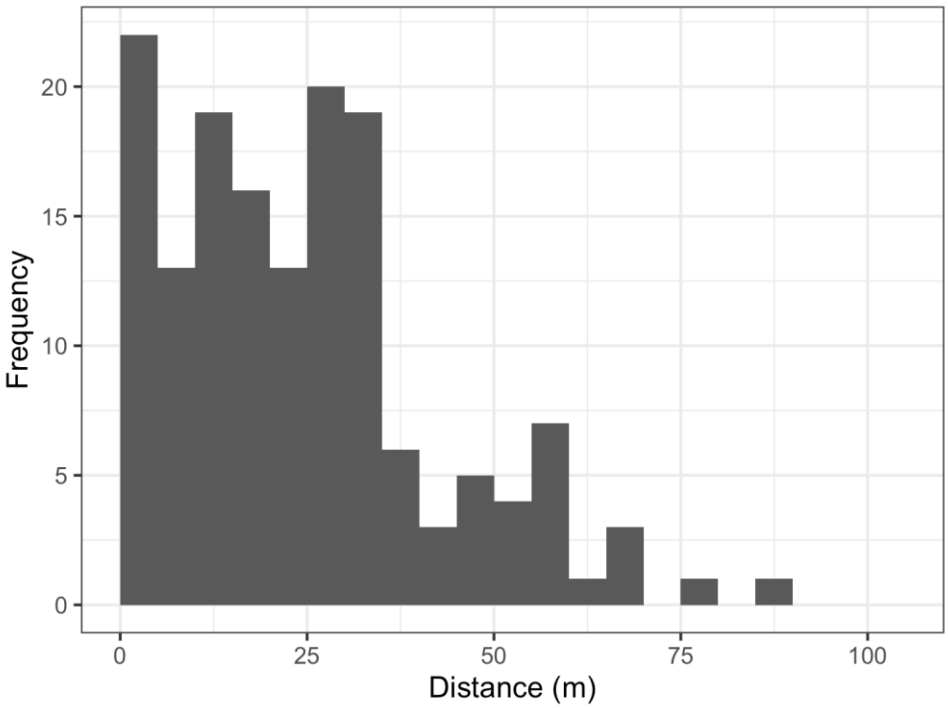

Figure 6. Histogram of ngwayir distance sampling data in 2019 from the three observers.

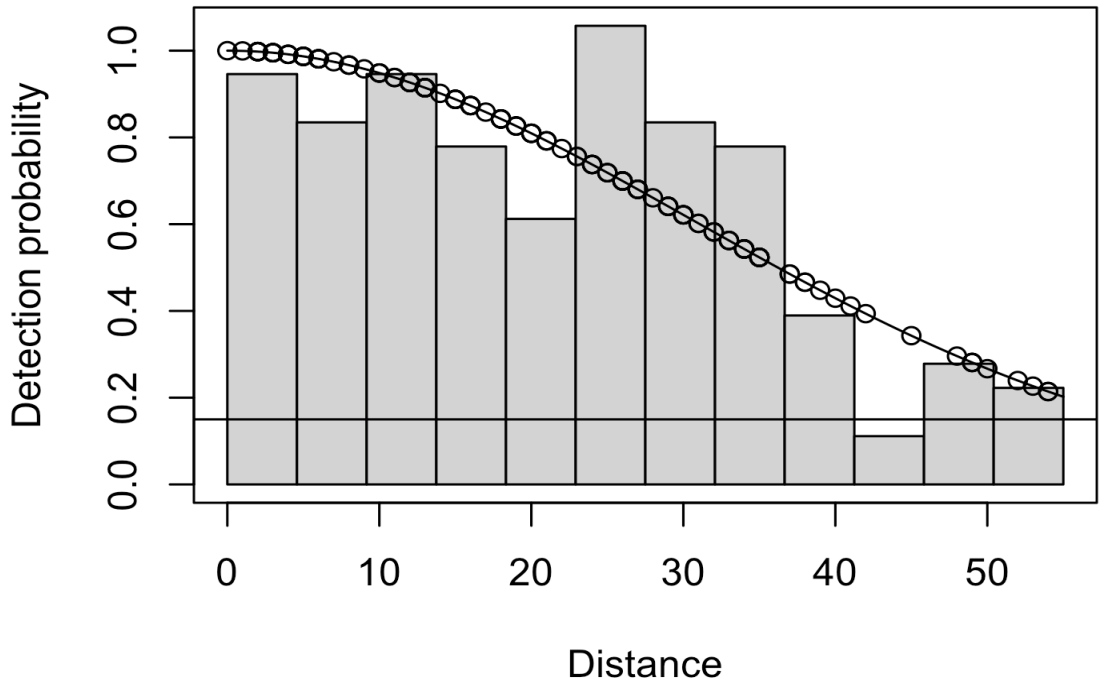

Figure 7. Fitted detection curve in relation to distance from transect (m), with truncation distance of 55 m, and horizontal line at 0.15 (demonstrating that the detection probability at the truncation distance was slightly greater than the desired 0.15).

3.2 2022 survey results

Pedestrian-based spotlight surveys were conducted between January and April 2022, in the ngwayir 'hotspot' within the Upper Warren (Figure 8). Six observers walked 111 separate line transects totalling 371.5 km of length (Table 1 and 3). There was a total of 438 ngwayir individuals detected in 361 events (Table 3 and 4). A total of 73 of these events involved the detection of a pair of ngwayir and on two occasions three were sighted together.

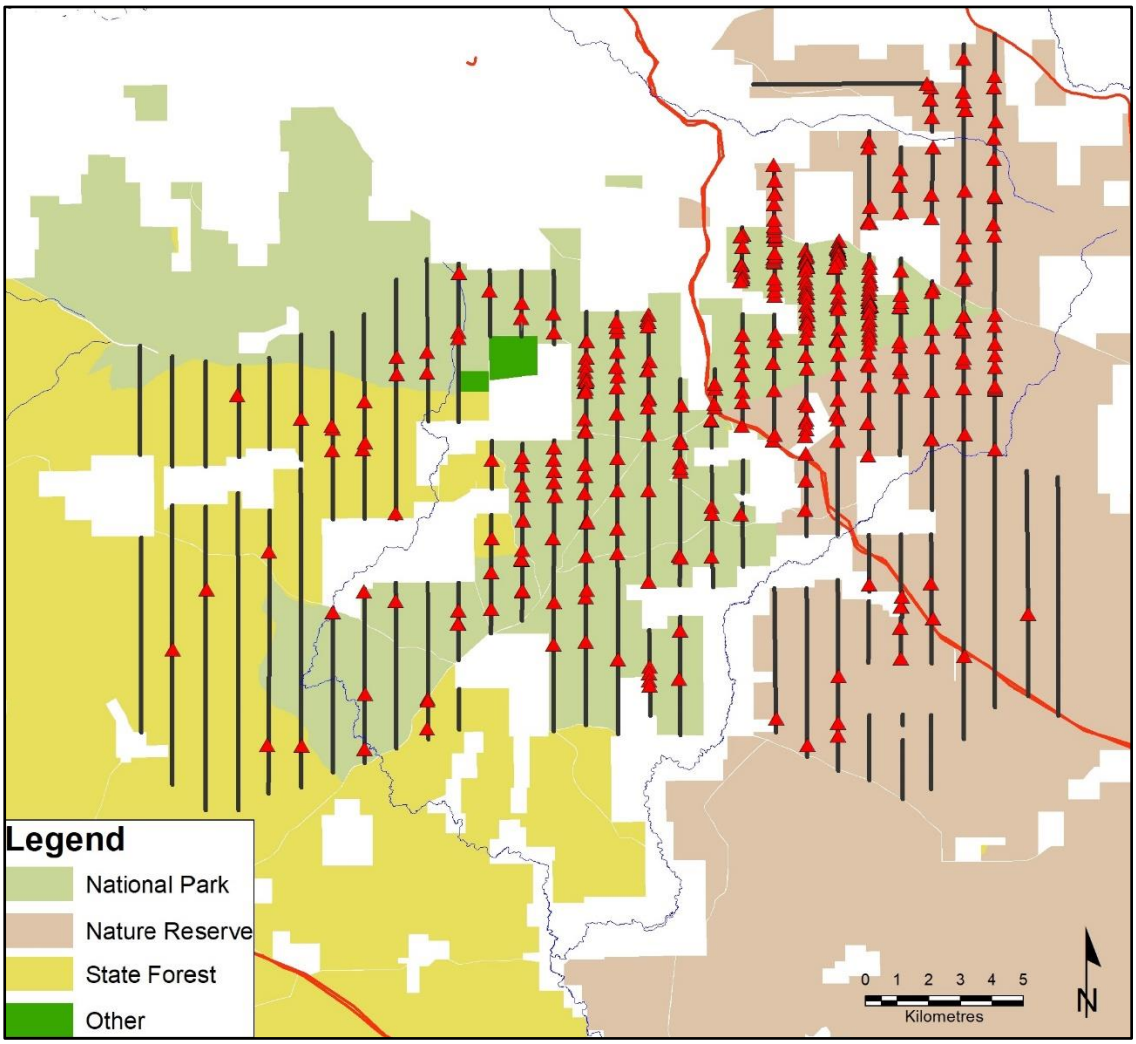

Figure 8. Independent sightings of ngwayir on transect during distance sampling spotlight surveys conducted in 2022 in the ngwayir 'hotspot' within the Upper Warren. Main sealed roads (red lines) and major hydrography (blue lines) are also depicted. Non-DBCA managed land (white areas) was not included in the surveys and is mostly freehold (private property) used for agriculture. Note this is a subset of the area surveyed in 2019 but at a finer spatial scale.

Table 3. Summary of which observers surveyed what transects, the total distance walked by each observer and the number of ngwayir detection events (unique individuals in parenthesis). Data from observers marked with an asterisk were removed from the final analysis.

Observer	Transects Surveyed	Total distance (km)	Ngwayir detection events (individuals)
AB	B2_AB, B3, C3, D2_AB1, D2_AB2, D3, E1, E2_AB, F1, F2_AB, I1, I2, K2A, L2, N2_AB, O2_AB, Q1, Q2_AB, Q3, R3, S1, S2, T2, U2, U4, V3, X2, X6, Y2, Z2, Z3, ZA3_AB, ZB1, ZB2_AB, ZB3	120.6	87(100)
AW	A2, E2_AW, E3, H1_AW, H2, J2, K2, P1, P2_AW, Q2_AW, R1, R2, T1, U1, W3, W4_AW, X3	62.2	120(149)
IW*	Y4B_IW, Z4_IW	5.4	2(2)
MM	A1, Alt Z1, B1, B2_MM, C2_MM1, C2_MM2, F2_MM, F3, F4, G1, G2, H1_MM, L1A, M2, N2_MM, O1, O2_MM, Q2_MM, S3, S4, T3, T4, V2, W5, X4, X5, Y3, Y4, Y4A, Y4B_MM, Z1, Z4_MM, ZA1_MM, ZA2_MM	109.4	111(134)
NT*	C1, K1, N1, O2_NT, W4_NT, Y5, Y6, Z5, ZA3_NT, ZB2_NT, ZC1, ZC2	35.4	20(22)
TR	D1, H1_TR, J1, L1, M1, P2_TR, V4, ZA1_TR, ZA2_TR, ZD1, ZD2	38.5	21(31)
Total		371.5	361(438)

Table 4. Summary of species detected during spotlight surveys on transect in the ngwayir 'hotspot' in the Upper Warren, 2022.

Species	Number of Detection events	Total number of individuals
Ngwayir	361	438
Koomal	877	1049
Woylie	122	125
Western grey kangaroo	30	43
Wambenger	24	24
Emu	5	10
Chuditch	9	9
Quenda	9	9
Tawny frogmouth	8	9
Red fox	3	4
Boobook owl	2	2
Tammar wallaby	2	2
Western brush wallaby	2	2
Barn owl	1	1

Threatened species were also opportunistically recorded while moving between transects. An additional 51 animals were recorded, including 15 ngwayir, five woylie and one chuditch. These ngwayir records were not included in the analyses. The records of threatened species will be provided to the DBCA, Parks and Wildlife, Donnelly District fauna sighting records database.

Exploratory analyses revealed significant differences in efficacy of detecting possums between observers during the surveys in 2022. Consequently, data collected by two observers were excluded: 'NT' (representing 35.4 km of transect and 20 detection events of ngwayir, Table 3) and 'IW' (representing 5.4 km of transect and 2 detection events of ngwayir, Table 3).

The final set of transects and locations of ngwayir detection events used in the analysis presented in this report are plotted in Figure 9 and a histogram of detection distances in Figure 10.

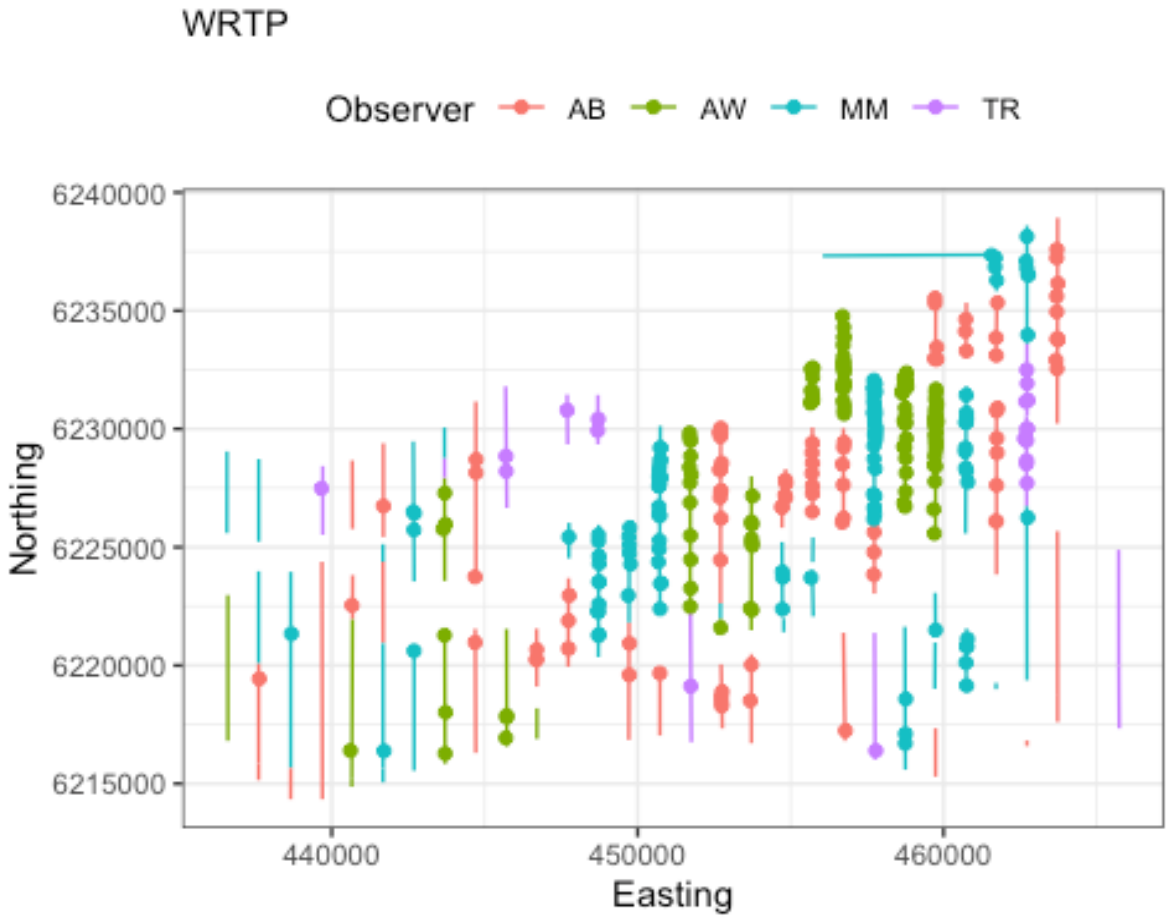

Figure 9. Location of transects and detection events for ngwayir in 2022, colour coded by observer, used in the distance sampling models.

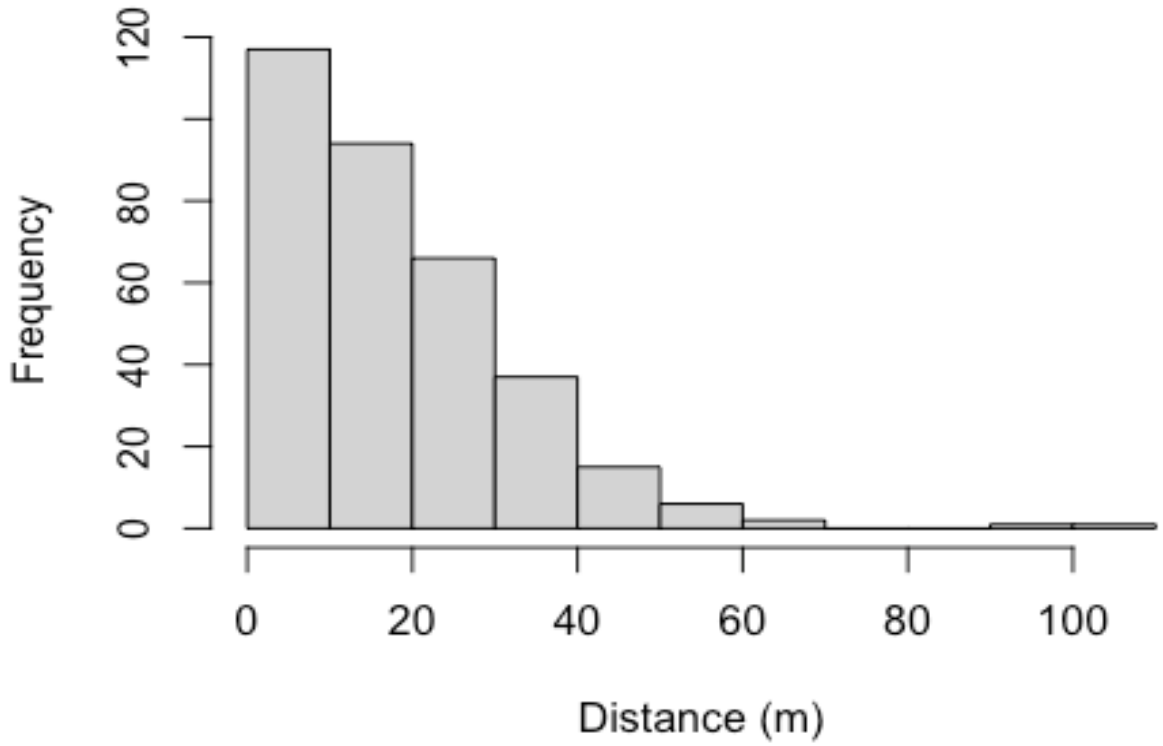

Figure 10. Histogram of the 2022 ngwayir distance sampling data from 4 final observers.

A truncation distance (*w*) of 45 m was used. That is, observations greater than 45 m were discarded from the analysis, representing about 4% of the total observations. This value met a rough rule-of-thumb that the top 5% of distance observations be truncated, and that the estimated detection probability at the truncation distance be 0.15 (i.e., $\hat{g}(w) \approx 0.15$, Buckland et a. 2001, p. 151). This truncation distance was different to that used in Biota (2020) of 55 m, but for these data 55 m represented a distance beyond which detection of possums was far below 0.15 and was 2% of the total observations in this data set. Like the best distance sampling model for the 2019 data, a half-normal detection function was used (Figure 11).

The distance sampling model (Buckland *et al.* 2001) estimated the population size of the ngwayir 'hotspot' (38,349 ha) surveyed in 2022 to be 8,341 individuals (7068 - 9842 95% Confidence Interval).

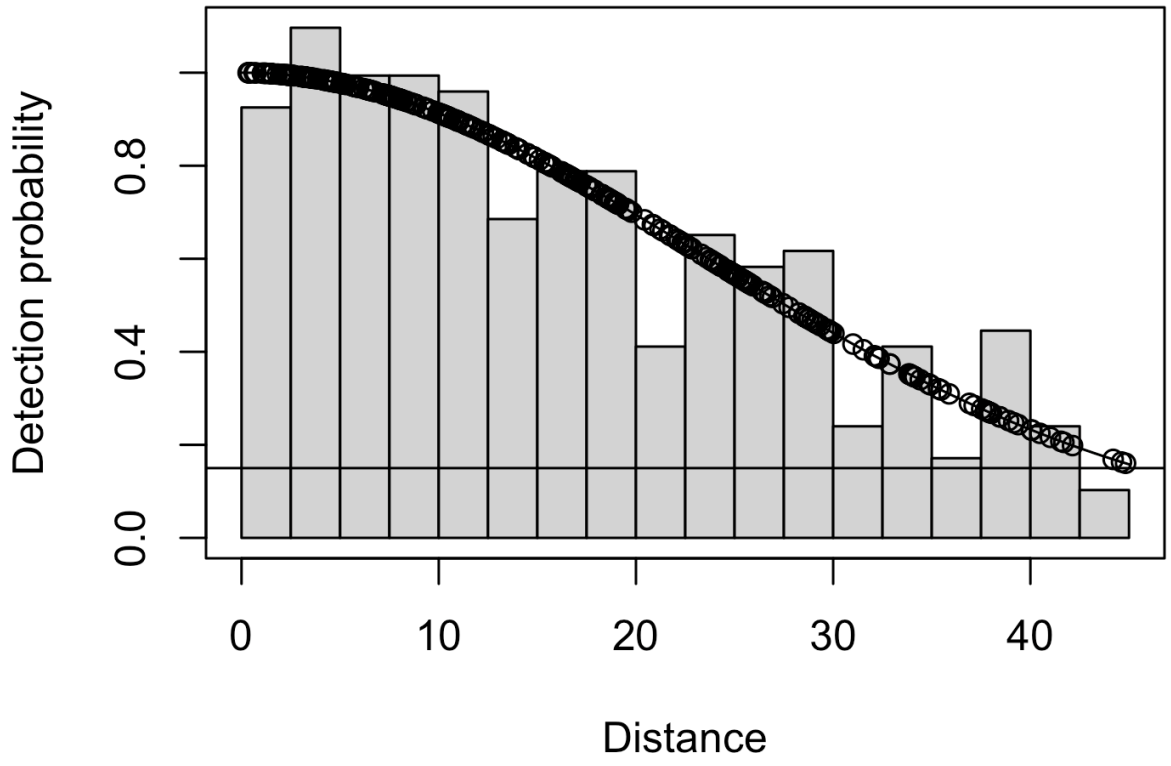

Figure 11. Fitted detection curve in relation to distance from transect (m), with truncation distance of 45 m, and horizontal line at 0.15 (demonstrating detection probability at the truncation distance is approximately 0.15).

3.3 2022 possum habitat use

All ngwayir were observed in arboreal locations, two thirds of which were 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 5% of observations being on terrestrial substrates and 63% being in trees larger than 40 cm DBH (Table 5a). There was no major difference in the species of tree used by both possum species (Table 5b). 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 12).

Table 5. Summary of the location of possums detected during the 2022 spotlight survey of the ngwayir hotspot in the Upper Warren.

a) Substrate structure

Species	n	Terrestrial	Arboreal				
		Ground / log	Shrub	Tree sapling (<15 cm d.)	Tree pole (15-40 cm d.)	Large tree (>40 cm d.)	Dead
Ngwayir	358	0.0%	0.8%	25.7%	41.1%	31.8%	0.6%
Koomal	873	4.9%	0.5%	5.8%	23.5%	63.2%	2.1%

b) Tree species. Note 'Other' includes *Eucalyptus rudis*, Banksia, Gastrolobium, Hakea, Melaleuca and unidentified tree species.

Species	n	Marri	Jarrah	Wandoo	Blackbutt	*Other
Ngwayir	361	55.4%	39.3%	2.8%	0.6%	1.9%
Koomal	834	59.5%	35.9%	2.8%	0.7%	1.2%

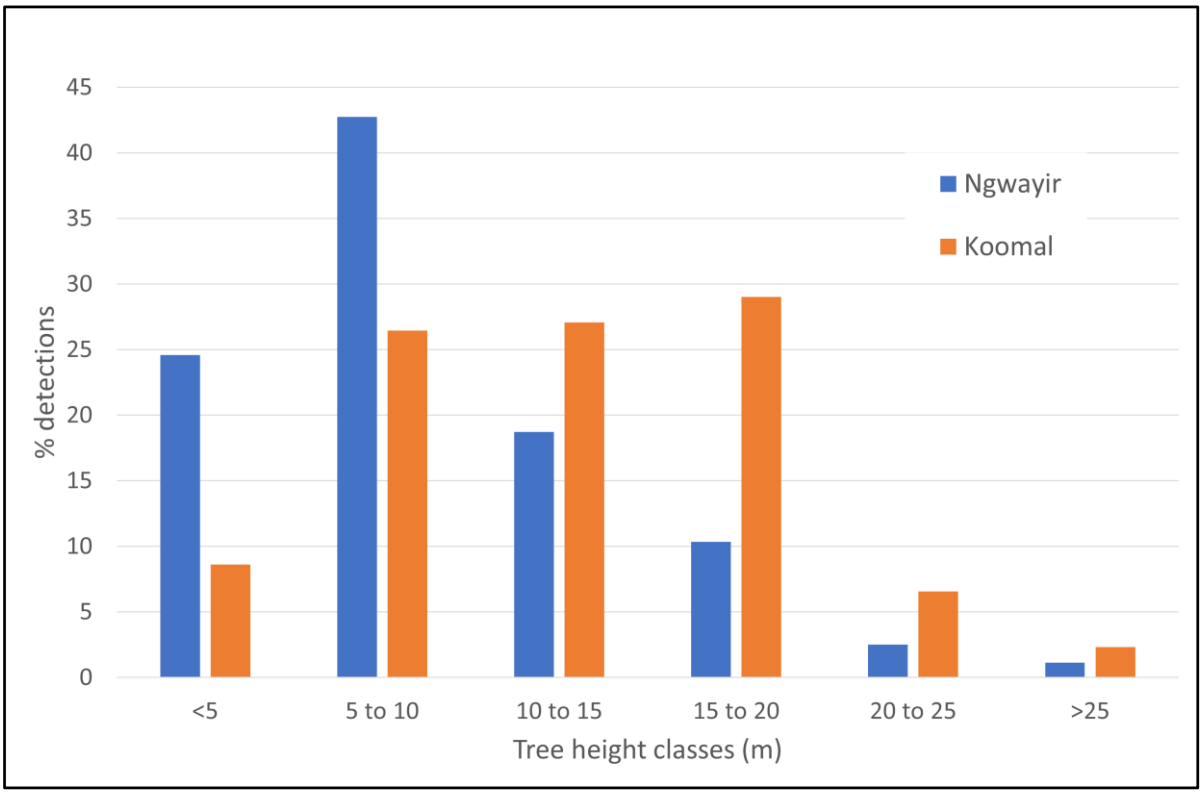

Figure 12. Height of ngwayir (n=358) and koomal (n=824) detected during spotlight surveys of the ngwayir 'hotspot' in the Upper Warren in 2022.

4 Conclusions

Ngwayir population in the Upper Warren:

- Population size: The ngwayir population in the Upper Warren remains large despite having undergone substantial declines during the last 20 years (Wayne *et al.* 2017; Wayne *et al.* 2012). Analysis of 2019 survey data estimated 8,423 (5,472 – 12,966, 95% CI) individuals in the Upper Warren (95,142 ha), similar to the population estimate of 8,341 individuals (7068 - 9842 95% CI) for the 'hotspot' (38,349 ha) in 2022.
- Spatial pattern: While detected across much of the region, the frequency of detections varied substantially across the region. Notwithstanding the possibility of population change during the 3-year period between surveys, these results suggest that the vast majority of the extant ngwayir population is within the so called 'hotspot'. The greatest densities of ngwayir are concentrated in Corbal, Dwalgan, Balban and Yendicup forest blocks.
- Temporal trends: It is not possible to reliably determine whether there have been any changes in the ngwayir numbers based on the surveys conducted in 2019 and 2022. This is because of the substantial differences in the spatial sampling (i.e., survey area, location of the transects and spatial resolution) between 2019 and 2022. Repeat surveys over time on the same transects will more reliably assess population trends.
- Habitat use: ngwayir observations were entirely in arboreal locations that tended to be in smaller trees and at lower heights than koomal.

Feasibility of sourcing ngwayir for translocation and supplementation for the Perup Sanctuary insurance population:

- The results of this study can inform an assessment of the merits of a possible establishment and/or maintenance of feral free enclosures to support insurance colonies of ngwayir, given its current critically endangered status, the history of substantial declines in numbers and range and the current and future threats to populations. This includes consideration of a possible supplementation of the insurance colony in the Perup Sanctuary.
- A greater understanding of population changes over time and space is essential for understanding the viability and potential risks of the population. It is also important to recognise that population change may be rapid and substantial given what has been previously observed (e.g., greater than 99% decline in less than 4 years; Wayne *et al.* 2017).
- The wild ngwayir population in the Upper Warren is considered large enough to harvest less than 50 animals without risk to the viability of the source population. Population Viability Modelling (PVA) is required to better quantify safe harvest levels.
- With nearly 25% of sightings being less than 5 m above ground there should be adequate opportunities to capture ngwayir using existing conventional methods such as tranquiliser darts.

- We can readily identify suitable areas of the Upper Warren from which it should be possible to efficiently harvest ngwayir given our much better understanding of the spatial distribution and densities of ngwayir across the region as a result of this study.

Recommendations:

- More detailed surveys are needed to better understand the extent of the ngwayir hotspot to the northeast of the area surveyed in 2022 (i.e. Yendicup and Keninup forest blocks).
- To better assess spatial and temporal changes in the ngwayir population, use a consistent survey methodology including resurveying the same transects over time. These surveys provide a valuable benchmark from which a robust population monitoring program could be developed.
- The data and results from these models can be used to investigate associations between possum densities and management activities (e.g., timber harvesting, burning, fox baiting), other anthropogenic factors (e.g., habitat fragmentation from agriculture, roading etc) and environmental factors (e.g., vegetation structure and floristics, landscape position, site moisture, proximity to surface water features).

5 Photo Evidence

Figure 13: Three of the observers that conducted the pedestrian-based spotlight surveys in the ngwayir hotspot in the Upper Warren, January – April 2022.

Figure 14: Ngwayir in Banksia grandis

Figure 15: Another ngwayir in another Banksia grandis

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