Transport for
New South Wales

Warrell Creek to Nambucca Heads

Annual Underpass Monitoring Report - Operational Phase, Year Four (2021-2022)

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Underpass monitoring – operational phase Year four (2022)

Sandpiper Ecological Surveys

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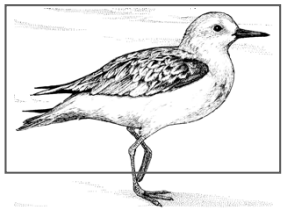

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1. Introduction

In 2015, Transport for NSW (TfNSW), in conjunction with Acciona Ferrovial Joint Venture (AFJV), commenced the upgrade of the Pacific Highway between Warrell Creek and Nambucca Heads (WC2NH). The WC2NH project was opened to traffic in two stages:

- Stage 2a - 13.5km section from Lower Warrell Creek Bridge to Nambucca Heads opened on 18 December 2017; and
- Stage 2b - 6.25km section from the southern end of the project to the Lower Warrell Creek bridge opened on 29 June 2018.

The Ministerial Conditions of Approval (MCoA) for the WC2NH upgrade included a requirement (MCoA B10) to prepare an Ecological Monitoring Program (EMP). The EMP was developed and approved in 2014 and later amended in 2018 (RMS 2018). Species and mitigation measures targeted in the EMP include koala, spotted-tailed quoll, grey-headed flying fox, yellow-bellied glider, giant barred frog, green-thighed frog breeding ponds, vegetated median, road-kill, exclusion fencing, threatened flora, and fauna underpasses.

As part of the project's approval (MCoA B1, B2, B3) fauna underpasses were installed "to maintain the viability of local terrestrial fauna populations by facilitating wildlife movement between proximate areas of habitat either side of the upgrade corridor and to accommodate use by several threatened fauna species including the spotted-tailed quoll, koala and giant barred frog" (RMS 2018). To assess the effectiveness of the fauna underpasses the EMP specified that operational phase monitoring should take place bi-annually (i.e., spring/summer and autumn/winter) for 5 years. The seasonal timing of monitoring was intended to align with the breeding and dispersal periods of targeted threatened species (i.e., koala, spotted-tailed quoll and giant barred frog).

The following report presents methods and the results of year four operational phase underpass and adjacent habitat monitoring. The objective of fauna underpass monitoring is "to assess use of underpasses by threatened and common fauna and to assess the effect of exclusion fencing on movement of small mammals, reptiles and frogs" (RMS 2018). Effectiveness of exclusion fence is assessed in the annual road-kill report (see Sandpiper Ecological 2022a). The results are discussed in relation to the potential indicators of success detailed in the WC2NH EMP (RMS 2018) and recommendations regarding future monitoring are provided. The potential indicators of success used to assess the performance of the WC2NH underpasses include:

1. Low rates of use of fauna underpasses and adjacent habitats by feral predators.
2. High levels of fauna underpass use by a wide variety of native fauna species.
3. No change to densities, distribution, habitat use, and movement patterns compared to baseline population data of target species.
4. Evidence of use by dispersing individuals and different age cohorts.
5. Use by cover-dependent species and species with low mobility.

A list of species names for fauna referred to in text and tables is provided in Appendix A.

2. Methods

2.1 Study area

The WC2NH project covers a total length of 19.75km and extends from Warrell Creek in the south to Nambucca Heads in the north (Figure 1). The alignment bypasses the town of Macksville and the northern section traverses Nambucca State Forest. The WC2NH upgrade features 23 fauna underpasses, including 13 box culverts, three pipe culverts and seven bridges. Underpasses targeted for monitoring were specified in the WC2NH EMP and include eleven box culverts and one bridge (RMS 2018; Table 1). Eleven underpasses are situated north of the Nambucca River and one (Site 1) is situated at Upper Warrell Creek near the southern extent of the project (Figure 1). Sites four to 12 adjoin Nambucca State Forest and sites two and three adjoin remnant vegetation on private land (Figure 1). Site five includes a dual cell box culvert with one cell designated as a wet passage (for aquatic fauna) and the other as dry passage (Plate 1). The dry cell includes a concrete ledge that provides dry passage for terrestrial fauna. Sites 9/10, and 11/12 consist of corresponding culverts on either side of a vegetated median (Plate 1). Fauna underpasses were designed to target spotted-tailed quoll, koala, and giant barred frog. Giant barred frog is known to occur at site 1 (Upper Warrell Creek) only, whilst quoll and koala could occur at sites 2-12.

Table 1: Underpasses sampled during operational phase monitoring of the WC2NH upgrade. SQ = spotted-tailed quoll; K = koala; GBF = giant barred frog; * sites consist of dual cells 3x3m box culverts with one cell providing wet passage for aquatic fauna; P/A = presence/absence.

Site	Chainage	Type	Structure	Dimensions	Fauna Furniture (P/A)	Substrate	SQ	K	GBF
1	42500	Combined	Bridge		A	Soil			x
2	55120	Dedicated	Box Culvert	1 x 3000 x 3000	P	Concrete	x	x	
3	56410	Combined	Box Culvert	1 x 2400 x 2400	P	Concrete	x	x	
4	57770	Dedicated	Box Culvert	1 x 3000 x 3000	P	Mulch	x	x	
5 *	58510	Combined	Box Culvert	2 x 3000 x 3000	A	Concrete	x	x	
6	58560	Dedicated	Box Culvert	1 x 3000 x 3000	P	Mulch	x	x	
7	59090	Dedicated	Box Culvert	1 x 3000 x 3000	P	Mulch	x	x	
8	59550	Dedicated	Box Culvert	1 x 3000 x 3000	P	Mulch	x	x	
9	59750 NB	Dedicated	Box Culvert	1 x 2400 x 2400	P	Mulch	x	x	
10	59760 SB	Dedicated	Box Culvert	1 x 2400 x 2400	P	Mulch	x	x	
11	60600 NB	Dedicated	Box Culvert	1 x 2400 x 2400	P	Mulch	x	x	
12	60610 SB	Dedicated	Box Culvert	1 x 2400 x 2400	P	Mulch	x	x	

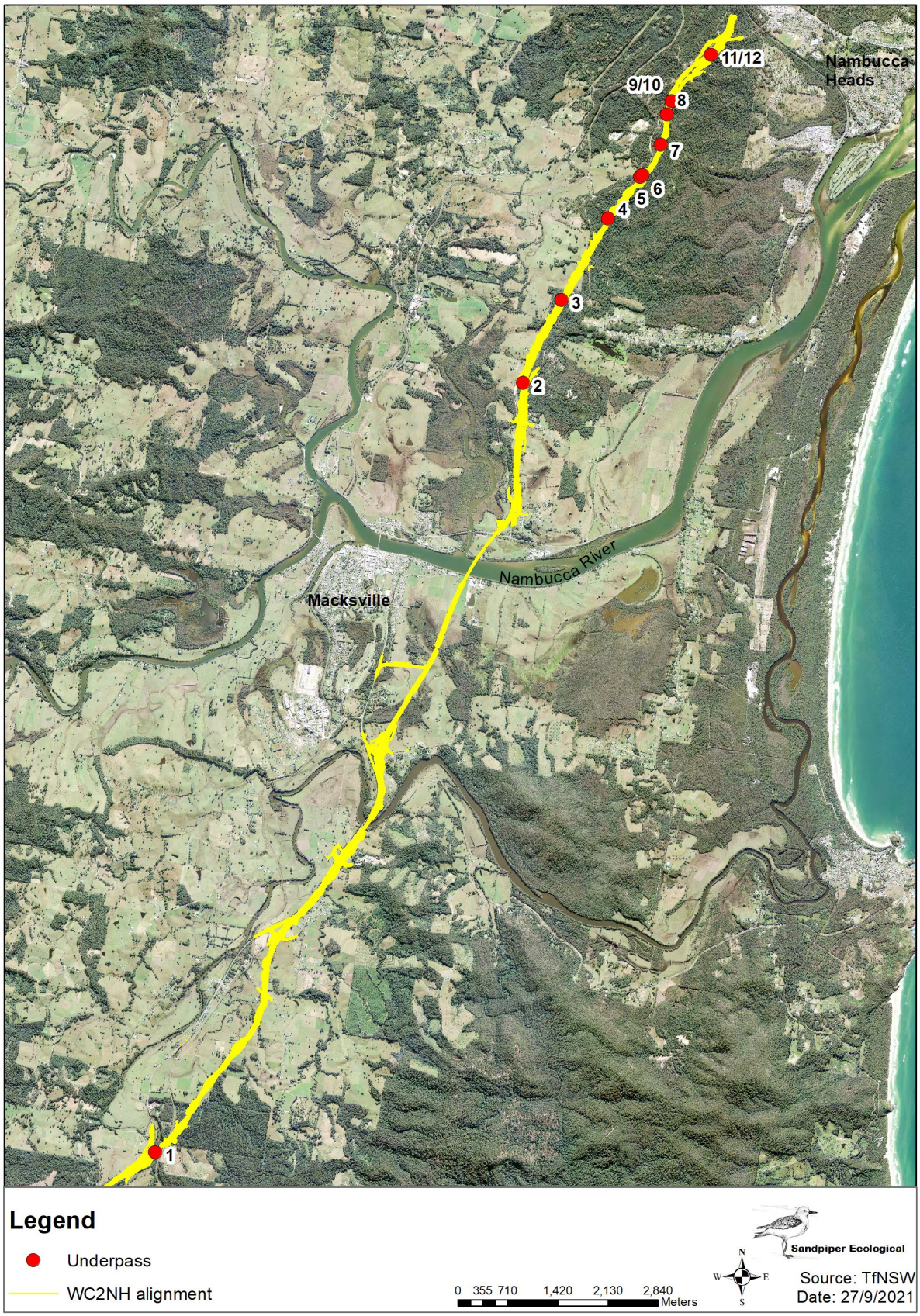

Figure 1: Underpass locations along the WC2NH alignment.

Plate 1. Dual box culverts with designated wet passage at site 5 (top left). Split median box culverts at site 9 and 10 (top right). Fauna furniture entering (bottom left) and exiting site 8 (bottom right).

2.2 Timing and weather conditions

Year 4 spring/summer operational phase underpass and adjacent habitat surveys were conducted between 15 November 2021 to 2 February 2022. Wet conditions prevailed during this period, with a total of 581 mm of rainfall recorded at the Bureau of Meteorology (BOM) Bellwood weather station (059150) (BOM, 2022). Conditions were warm, with maximum temperatures ranging from 20.1 to 34.1 ^{0}C (BOM, 2022a).

Winter surveys were conducted between 1 July and 31 August 2022. Conditions during this period were typically cool to mild with maximum temperatures ranging from 15.6 to 25.6 ^{0}C (Table 2). A total of 336 mm of rainfall was recorded, most of which was recorded on 6 (118mm) and 7 (104mm) July (BoM 2022).

Table 2: Summary of weather conditions recorded at Coffs Harbour Airport (station 059151) and Bellwood weather station (rainfall only, 059150) during year four operational phase monitoring.

Monitoring period	Total rainfall (mm)	No. rain days	Max temp range (^{0}C)	Min temp range (^{0}C)
Spring/Summer	581	36	21.7-32.1	6.7-25
Winter	336	18	15.6 to 25.6	1.9-15.6

2.3 Underpass monitoring

2.2.1 Sand pads

Sand pads were installed using a 50:50 mix of brickies sand and washed beach sand. One sand pad was installed centrally in culverts, whilst at the bridge (site 1), two pads were installed on the northern side of Warrell Creek. Each pad was approximately 50 mm deep by 1m wide and extended for the entire culvert width or 3-4m at site 1. The sand pad covered both the floor and ledge at sites with a concrete ledge (Plate 2). The exception was site 5, where the pad covered the ledge only due to standing water over the culvert floor. Sand pads were installed at the commencement of both the spring/summer and winter sample periods.

Sand pads were inspected on eight consecutive days during the spring/summer and winter sample periods. Inspections were conducted by an ecologist and included a systematic scan of each pad searching for fauna tracks. A small torch was used to illuminate the pad, if required. Information recorded included species or fauna group, number of traverses, direction of traverse and pad condition (good, fair, poor). Tracks were identified with reference to Triggs (2004) and advice from senior ecologists. Tracks that could not be identified insitu were photographed and referred to a senior ecologist for identification.

Plate 2. Sand pad being installed in a fauna underpass (Site 3) on the WC2NH upgrade.

2.2.2 Scat and track searches

An ecologist searched each underpass for scats and tracks on two occasions during both the spring/summer and winter sample periods. The search involved a slow systematic traverse of each culvert using a hand-held spotlight (Led Lenser P14). Fauna furniture, the culvert floor, and the culvert joints were targeted. Sand pads and areas of accumulated fine sediment were inspected for tracks. Tracks and scats were identified in-situ, with reference to Triggs (2004) and the ecologist's experience or photographed and sent to colleagues for identification.

2.2.3 Tile checks

In autumn 2020, two roof tiles (300x200) were installed 5 m from both ends of each underpass, excluding site 1, to target small mammals, reptiles and frogs. Tiles were inspected on eight occasions during the spring/summer and winter sample periods.

2.2.4 Cameras

Two motion-activated infra-red cameras (Swift 3C, Swift Enduro or Reconyx HC500) were installed centrally in each culvert or were housed in security boxes and attached to concrete posts for the bridge underpass at site 1. A total of 24 cameras were installed with 22 in culverts and two at the site 1 bridge. In culverts, both cameras were installed centrally, one on the fauna furniture, and one approximately 300mm above the culvert floor. All cameras in culverts were installed facing east with the exception of site 10 ground which was reorientated west due to repeated false triggers from southbound traffic. At the bridge underpass at site 1, Reconyx cameras were installed at approximately 200 mm above ground near the water's edge attached to a concrete post on each side of Upper Warrell Creek (site 1). Cameras were oriented perpendicular to the creek on the north and south banks.

Swift cameras were set on high sensitivity and programmed to take 10 seconds of video on activation. Reconyx cameras in culverts were set to high sensitivity and programmed to take a three-photo burst on activation. Reconyx cameras at site 1 were set on time-lapse mode and programmed to take a picture at 1-minute intervals between 6 pm and 6 am each day throughout the spring/summer and winter sample periods. Time-lapse mode is better suited to targeting frogs and was used successfully to monitor frog pipes on the Sapphire to Woolgoolga Pacific Highway Upgrade (Sandpiper Ecological 2017a, 2018a). Cameras at site 1 were originally installed during autumn, however flooding led to the disruption of monitoring with cameras being reinstalled during the winter survey period to satisfy monitoring requirements.

During the spring/summer sample period, cameras at sites 1-12 were installed on 23-25 November 2021 and were retrieved on 2 February 2022 following a total sample period of 71 days (Table 3). During the winter sample period, cameras at sites 1-12 were installed on 1 July 2022 and were retrieved on 31 August 2022 following a total sample period of 61 days (Table 3). On fourteen occasions camera effort was hindered by battery failure (six occasions), SD card error (six occasions) and flooding (2 occasions) (Table 3). As specified within the EMP at least two cameras were active for a minimum of 60 days per sample period at sites 2, 3, 5/6, 8, 9/10 and 11/12. Camera effort was reduced at sites 1 (spring/summer and winter), 4 (spring/summer only) and 7 (spring/summer and winter) during year four operational monitoring (Table 3). To resolve future issues with SD card errors new SD cards have been obtained.

Table 3: Camera survey effort during year four operational phase monitoring. SS = spring/summer. W= Winter [!] **=** SD card error * = Camera malfunction/battery failure. F = flooding.

Site	Camera type	Camera location	Number of days active		
			Spring/summer	Winter	Total Year 4
1	Reconyx	North	56*[F]	51*	107
	Reconyx	South	52*[F]	43*	95
2	Reconyx	Furniture	68	61	129
	Swift enduro	Ground	71	61	132
3	Swift enduro	Furniture	71	61	132
	Swift enduro	Ground	71	61	132
4	Swift 3c	Ground	36[!]	61	97
	Swift enduro	Furniture	29*	61	90
5	Swift enduro	North	71	36[!]	107
	Swift enduro	South	71	25[!]	96
6	Reconyx	Furniture	71	61	132
	Reconyx	Ground	71	61	132
7	Swift 3c	Ground	29[!]	56	85
	Swift enduro	Furniture	71	61	132
8	Swift enduro	Furniture	71	61	132
	Swift enduro	Ground	71	61	132
9	Swift 3c	Ground	71	36[!]	107
	Swift enduro	Furniture	12*	61	73
10	Swift enduro	Furniture	71	61	132
	Swift enduro	Ground	71	61	132
11	Swift enduro	Furniture	71	25[!]	96
	Swift enduro	Ground	71	61	132
12	Swift enduro	Furniture	71	61	132
	Swift enduro	Ground	71	61	132

Image review

Images were uploaded to a computer and viewed using Windows Photo Viewer ©. A senior ecologist or ecologist reviewed all images, with reference to standard field guides (i.e., Menkhorst & Knight 2004; Pizzey & Knight 2007; Van Dyck *et al.* undated).

Fauna were scored making a complete or incomplete crossing:

- A complete crossing was scored when an animal showed directional movement when detected by the centrally mounted camera.
- An incomplete crossing was scored when an animal showed no directional movement (i.e., remained stationary in front of camera) or passed the camera but returned within 10 minutes.

Crossing definitions are consistent with those used at other Pacific Highway monitoring sites (e.g. Sandpiper Ecological 2017b, 2018b, 2019) and crossing structure research programs (e.g. Soanes *et al.* 2015). Further, it represents a conservative approach to identification of complete crossings. Data recorded for fauna records included movement direction (i.e.,, east, west or no-directional movement - NDM) and a tally of crossing types. A hierarchical approach was adopted to species identification, including species, genus or group. Microbats were recorded as present only due to their transient nature and non-reliance on underpasses for thoroughfare.

Data analysis and interpretation

To adequately assess "use of underpasses" as per the monitoring aim, complete crossings were used as the standard measure for fauna activity as it encompasses the purpose of fauna underpasses (i.e.,, A structure that allows fauna to access habitat that has been fragmented by the construction of a road or highway). To account for variations in survey effort between sites, complete crossings/week and complete crossings/week/underpass were adopted. Complete crossings have been pooled and presented in relation to monitoring periods (i.e., year 1 vs year 2), taxa (i.e., bandicoots, possums, and wallabies), and sites (i.e 1, 2, 3). Survey effort and complete crossings at underpasses 5/6 (proximity), 9/10 (split median), and 11/12 (split median) were combined during data analysis as they function as a single site and lack independence if treated separately. While pooling data, complete crossings of fauna have been averaged according to the number of cameras per underpass (i.e., 11/12 n=4). This same approach has been applied to data from previous monitoring years and projects. Birds and microbats were excluded from analysis as they do not require underpasses for thoroughfare.

As seen in dot point five in the potential indicators of success (see introduction), fauna with low mobility was not defined within the EMP. As such, fauna with low mobility has been assumed to include animals whose movement is generally limited by their size or behaviour. Hence, fauna that exhibit low mobility/cover dependence has been interpreted as frogs, small reptiles (excluding goanna and water dragon), rodents and bandicoots.

2.3 Adjacent habitat survey

2.3.1 Survey design

A total of 18 sites were sampled at the 12 underpasses as part of adjacent habitat survey. Sample sites were established on each side of an underpass or underpass pair in the case of sites 5/6, 9/10 and 11/12. Adjacent habitat at sites 5 and 6 were sampled as one site as the underpass entrances were located within 50 m of each other. Survey effort was reduced at site 3 due to concern about disturbing neighbours. No spotlighting or arboreal Elliott trapping occurred on the west side at site 3 and the diurnal active search was restricted to a small (100m x 30m) triangular-shaped remnant of vegetation in the road reserve.

2.3.2 Trapping

Trapping methods applied during the survey included: cage traps, ground Elliott traps (Type A), arboreal Elliott traps (Type B), pitfall traps, and hair funnels. Trapping occurred within a 1 ha area immediately adjacent to each culvert entrance and was conducted over three nights at each site. All sites were sampled concurrently, with trapping occurring between 17 and 19 November 2021.

Traps were set in an "X" formation with five ground and five arboreal traps set at 20 m intervals on one axis, two cage traps, and two hair funnels set at 50 m spacing on the other axis (Plate 3). A line of three pitfall traps with a drift fence set at the intersection of both lines (Plate 3). Pitfall traps typically followed the contour and were set near fallen logs and dense ground cover. The trap effort is summarised in Table 4.

Plate 3: Example of a pitfall trap line installed during adjacent habitat surveys (L). Setting up traps in adjacent habitat at site 1 (R).

Arboreal traps and ground Elliott traps were baited with a peanut butter, honey and oats mixture. Arboreal traps were installed 1.8m above ground and attached to a bracket. Honey water was sprayed on the trunk above each arboreal trap, and bait was replaced as required. A plastic bag was placed over the end of each trap to provide cover, and a small amount of leaf litter was placed inside the trap. In spring/summer, arboreal traps were set on the western side of trees to provide shelter from the morning sun. Cage traps were set in a sheltered location and alternately baited with either peanut butter, honey and oats, or sardines. A tuna oil and water mix was sprayed around the entrance to cage traps baited with sardines. All traps were checked within four hours of sunrise.

Captured fauna were identified to species or genus, and, where possible, sexed and aged. Fauna were identified with reference to standard field guides (Van Dyck *et al.* 2013; Menkhorst & Knight 2004; Wilson & Swan 2010). Fauna were not marked as sampling aimed to determine the range of species present in adjacent habitat.

2.3.3 Diurnal active search

Diurnal active searches were conducted by one or two ecologists and involved a meandering traverse of habitat within 100 m of the underpass entrance at each sample site. Surveys involved searching leaf litter, rolling logs, observing reptile habitat (i.e.,, log piles, rocks, dense leaf litter) and looking for fauna signs such as scats and tracks. Each site was sampled twice during each sample period for a minimum of 30 person minutes/sample.

2.3.4 Nocturnal active search

Nocturnal surveys were conducted by one or two ecologists and involved a meandering traverse of habitat within 100 m of the culvert entrance using hand-held Led Lenser P14 spotlights. Fauna were detected by sight and call and identified to species or genus where possible. Each site was sampled twice during each sample period for a minimum of 30 person minutes/sample.

2.3.5 Opportunistic records

Opportunistic observations of fauna near culvert entrances were made whilst doing other monitoring activities such as koala, giant barred frog and yellow-bellied glider monitoring. All fauna observed whilst setting up equipment, apart from birds, were also recorded.

Table 4: Survey effort for sampling adjacent habitat on the WC2NH upgrade.

Component	Method / culvert side	No Samples	Total effort
Arboreal Elliott traps	5 x traps @ 20m spacing	3 nights/site	510 trap nights
Ground Elliott traps	5 x Type A Elliott traps @ 20m spacing	3 nights/site	540 trap nights
Cage traps	2 @ 50m spacing	3 nights/site	216 trap nights
Pitfall traps	1 x line of 3 pits with drift fence	3 nights/site	324 trap nights
Hair funnels	2 @ 50m spacing	14 nights/site	504 trap nights
Active diurnal search	30 person minute search at UP entrance	2 sample/site	1080 person minutes
Active nocturnal search	30 person minute search at UP entrance	2 samples/site	1080 person minutes

3. Results

3.1 Underpasses

3.1.1 Year four camera monitoring

Species diversity and underpass use

Twenty-three species/unique genera and eight fauna groups were confirmed using (complete crossings) underpasses at WC2NH during year four operational phase monitoring (Table 5). Fauna groups included eight taxa that could only be identified to a genus or group, including *Antechinus* spp. rodent spp., *Rattus* spp. bandicoot spp., wallaby spp., lizard spp., *Chelidae* spp., and *Trichosurus* spp. (Table 5). Rodent, Rattus, bandicoot, wallaby and *Trichosurus* spp. likely belong to confirmed species in Table 5 (i.e., *Trichosurus* spp. either short-eared brushtail possum or common brushtail possum). Of the fauna recorded, eighteen were native species and six were introduced including cat, wild dog, red fox, black rat, house mouse and European hare (Table 5). Native fauna diversity was highest at sites 9/10 and 11/12 with thirteen species/groups, followed by sites 7 and 8 with twelve species/groups (Table 5). Native fauna diversity was lowest at site 1 with three species recorded (Table 5). Sites 2, 3, 4, and 5/6 recorded between seven and eleven native fauna species/groups (Table 5).

Underpass use by native species was recorded at all sites during year four camera monitoring at an overall rate of 2.57 ± 0.52complete crossings (cc)/week/site (Figure 2, Figure 4). Sites 7 and 8 featured the highest use by native fauna with an average of 4.7cc/week and 3.86cc/week, respectively (Figure 2). Sites 1 and 5/6 exhibited the lowest use by native fauna, recording 0.11cc/week and 0.93cc/week respectively (Figure 2). Native fauna use was higher than that of feral predators and rodent spp. across all sites (Figure 2).

Short-eared brushtail possum was the most frequently recorded native species, with a total of 11.83cc/week across all sites (Table 5, Plate 4). This was followed by bandicoot species, including long-nosed and northern brown with 9.75cc/week, *Antechinus* spp. (6.57cc/week, Plate 4) swamp wallaby (5.58cc/week), wallaby spp. (4.30cc/week) and *Trichosurus* spp. (2.69cc/week) (Table 5).

Noteworthy detections included koala using the culvert floor (ground) at sites 2 (one occasion), 4 (two occasions Plate 4) and 11/12 (two occasions, Plate 4) to make a complete crossing of the alignment (Table 5, Figure 2).

Use by cover-dependent species

Cover-dependent fauna (see classification in methods) were recorded at all sites (Table 5). In order of underpass use, rodent spp. recorded a total of 20.2 cc/week, bandicoots 9.75cc/week, *Antechinus* spp. 6.57 cc/week and the introduced black rat with 4.25cc/week (see total Table 5). Confirmed rodent species were black rat (underpasses 2,4,5,7,8,9/10, 11/12), fawn-footed melomys (site 2, 5/6, 7, 8, 9/10), water rat (site 5) and bush rat (site 9/10) (Table 5). Other cover-dependent species included the eastern blue-tongue lizard using the culvert floor on one occasion at site 9/10 and *Egernia* spp. with complete crossings at sites 2, 7, 8, and 9/10 (Table 5). No frogs were recorded using underpasses during camera monitoring. Most cover-depended species favoured the fauna furniture over the culvert floor (Table 5).

Furniture vs Floor

Fauna were recorded using (complete crossings) both the culvert floor (55% of complete crossings) and furniture (45%) during year four operational phase monitoring (Table 5, Figure 3). Native fauna accounted for most complete crossings on both the culvert floor (58%) and fauna furniture (50%) (Figure 3). Rodent spp. and introduced rodents ((i.e., house mouse and black rat) tended to favour using the fauna furniture whereas feral predators showed preferential use of the culvert floor with only a few records of cat using the furniture at sites 3 and 8 (Figure 3, Table 5). Most of the native fauna usage on the furniture can be attributed to high preferential use by brushtail possums (combined short-eared brushtail possum, common brushtail possum and *Trichosurus* spp.) and *Antechinus spp.* particularly at sites 4, 7 and 8 (Table 5, Plate 4). Of the threatened fauna, koalas were recorded using the floor only (Table 5, Plate 4).

Feral predator activity

Feral predators were recorded in all underpass sites except for site 1 and site 7 and accounted for 18% of all complete crossings (Figure 2, Table 5). Cat recorded the highest combined use (9.58cc/week), followed by red fox (5.13 cc/week) and dog (0.03 cc/week) (Figure 2, Table 5). Cat activity was recorded across seven of nine sites at an overall rate of 0.53 ± 0.4 cc/week/underpass, with the highest activity (combined total of 6.89 cc/week) occurring at site 3 (Table 5, Figures 2 and 5). Fox activity was recorded at seven of the nine sites at an overall rate of 0.29 ± 0.1 cc/week/underpass, and no records at site 7 or site 1 (Table 5, Figures 2 and 5). Dog activity was only recorded at site 11/12, with one crossing contributing to an overall rate of 0.001 ± 0.001 cc/week/underpass (Table 5, Figures 2 and 5, Plate 4). No instances of predation were recorded in underpasses during year four operational monitoring.

Plate 4: Koala recorded travelling west at site 4 during spring/summer monitoring (Top left). Koala using the culvert floor to travel east at 11/12 split median during winter (Top right). Antechinus spp. using the furniture at site 7 (Middle left). Short-eared brushtail possum travelling west at site 8 on the furniture (Middle right). Fox heading west at split median 9/10 (Bottom left). Wild dog travelling west at split median 11/12 (Bottom right).

Table 5: Mean number of complete crossings/week/site made by each species/group at nine underpass sites monitored on the WC2NH upgrade during year 4 operational monitoring. FF= fauna furniture and G= ground (culvert floor). Site 1 did not contain fauna furniture. Species in bold denote threatened species, ^=Cover-dependent species. * = Introduced species. See appendix B, Table B1 for all data.

Species/fauna groups	Site and camera location																	Cumulative total cc/week/species
	1	2		3		4		5/6		7		8		9/10		11/12		
	G	FF	G	FF	G	FF	G	FF	G	FF	G	FF	G	FF	G	FF	G	
Mammals																		
Short-beaked echidna	-	-	-	-	-	-	-	-	0.04	-	-	-	0.05	-	0.14	-	0.03	**0.26**
Antechinus spp.^	0.07	1.52	-	-	-	0.14	-	0.58	-	2.14	-	1.22	-	0.70	0.07	0.12	-	**6.57**
Long-nosed bandicoot^	-	-	-	-	0.05	-	-	-	0.36	-	0.37	-	0.21	-	0.34	-	0.88	**2.21**
Northern brown bandicoot^	-	-	-	-	0.05	-	-	-	0.02	-	0.11	-	0.16	-	-	-	0.45	**0.79**
Bandicoot spp.^	-	-	1.01	-	0.32	-	0.93	-	0.21	-	1.17	-	0.85	-	1.23	-	1.03	**6.75**
Koala	-	-	0.05	-	-	-	0.16	-	-	-	-	-	-	-	-	-	0.05	**0.26**
Common brushtail possum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	-	**0.03**
Short-eared brushtail possum	-	-	-	0.11	-	2.45	0.16	0.27	-	5.44	0.05	1.80	-	0.76	0.03	0.71	0.05	**11.83**
Trichosurus spp.	-	-	0.11	0.11	-	0.51	-	-	-	0.33	0.05	0.37	-	0.21	0.27	0.74	-	**2.69**
Eastern grey kangaroo	-	-	-	-	1.54	-	-	-	-	-	-	-	-	-	-	-	-	**1.54**
Red-necked wallaby	-	-	-	-	0.05	-	-	-	-	-	-	-	-	-	-	-	-	**0.05**
Swamp wallaby	0.07	-	0.74	-	0.21	-	2.41	-	-	-	0.48	-	1.54	-	0.10	-	0.03	**5.58**
Wallaby spp.	-	-	1.38	-	0.95	-	-	-	-	-	0.64	-	1.22	-	0.03	-	0.08	**4.30**
Fawn-footed melomys^	-	0.05	-	-	-	-	-	0.11	-	0.25	-	0.05	-	0.09	-	-	-	**0.55**
Water rat^	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	**0.29**
Bush rat^	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	**0.06**
European hare*	-	-	-	-	-	-	-	-	0.1	-	-	-	0.1	-	-	-	0.0	**0.16**
Introduced and rodent spp.																		
House mouse*^	0.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.03**
Black rat*^	-	-	-	-	-	1.59	-	0.42	-	1.32	0.42	0.11	-	0.15	0.24	-	-	**4.25**
Rattus spp.^	-	0.54	-	-	-	-	-	-	0.06	-	-	-	-	-	-	0.03	-	**0.64**
Rodent spp.^	-	1.19	0.16	-	0.16	3.32	0.31	2.55	0.13	2.96	0.58	5.46	-	0.85	1.47	0.95	0.11	**20.20**
Feral predators																		
Red fox*	-	-	0.69	-	0.32	-	0.31	-	0.23	-	-	-	1.22	-	0.82	-	1.59	**5.18**
Wild dog*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	**0.03**
Cat*	-	-	0.11	0.48	6.89	-	0.16	-	0.08	-	-	0.58	1.01	-	0.14	-	0.13	**9.58**
Reptiles																		
Chelidae spp.	-	-	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.05**
Blue-tongue lizard^	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-	-	**0.07**
Eastern crevice skink^	-	0.11	-	-	-	-	-	-	-	0.08	-	0.05	-	0.23	-	0.09	-	**0.57**
Eastern water dragon^	-	-	-	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	**0.08**
Lace monitor	-	-	-	-	0.11	0.22	-	-	0.08	0.41	0.32	-	0.37	0.03	0.14	-	0.03	**1.70**
Lizard spp.	-	0.05	-	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.11**
Coastal carpet python	-	-	-	-	-	-	-	-	-	0.08	-	-	-	-	-	-	-	**0.08**
Total cc/week/cam	**0.17**	**3.47**	**4.30**	**0.74**	**10.66**	**8.23**	**4.51**	**3.92**	**1.55**	**13.01**	**4.19**	**9.65**	**6.63**	**3.08**	**4.95**	**2.67**	**4.48**	**86.21**

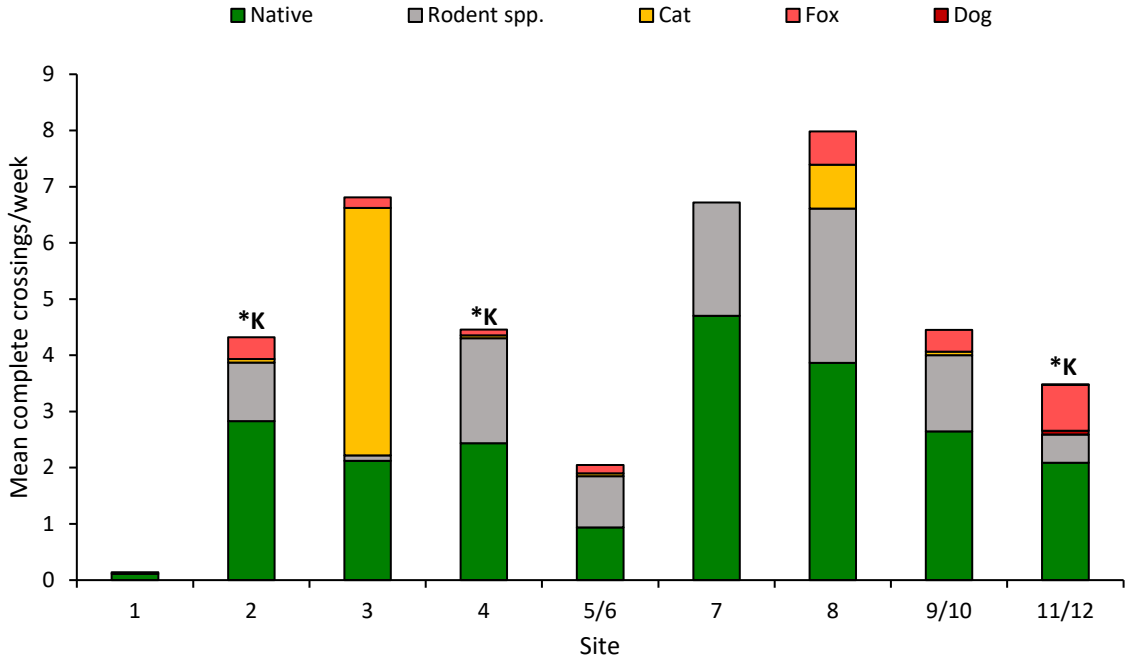

Figure 2: Mean complete crossings (cc)/week/site by native species, feral predators (cat, dog and red fox) rodent spp. (combined black rat, house mouse and rodent spp.) at each site during year four operational monitoring, WC2NH, 2021-2022. *K = indicates complete crossing by koala. European has been removed due to limited records.

Figure 3: The proportion of complete crossings recorded on the culvert floor (ground) vs the fauna furniture by native species, feral predators (cat, dog, and red fox) rodent spp., and introduced species (European hare, black rat and house mouse) at WC2NH during year four operational monitoring, 2021-2022.

3.1.2 Operational camera monitoring

Excluding microbats and birds, underpass cameras during year four operational monitoring yielded 1893 fauna detections (i.e., sum of complete, incomplete and non-directional movement crossings) (See appendix B, Table B1). Complete crossings (cc) accounted for 92% (1743cc) of all fauna detections at an overall rate of 4.7± 0.54 cc/week/site (combined native, feral predator, introduced, and rodent spp.) at WC2NH (Figure 4). The rate of complete crossings/week/site has been the highest recorded since the commencement of operational monitoring in year one and has continued the general trend of the increasing number of complete crossings over time (Figure 4).

Native fauna accounted for most of the complete crossings during year four monitoring with a rate of 2.57 ± 0.52 cc/week/site followed by rodent spp. (1.07 ± 0.29 cc/week/site), feral predators (0.83 ± 0.4 cc/week/site) and introduced species (0.23 ± 0.1 cc/week/site) (Figure 4). Underpass use by native fauna has continued to increase, with the highest mean number of complete crossings recorded during year four monitoring (Figure 4). Similarly, rodent spp. (either melomys, bush rat, black rat or swamp rat) use has tended to increase over time, going from 0.01 ± 0.001 cc/week/site in year one monitoring to 1.01 ± 0.29 cc/week/site during year four (Figure 4). Feral predator use of the WC2NH underpass sites has decreased since year one (1.37 ± 1.02 cc/week/site) and two (1.65 ± 0.29 cc/week/site) monitoring periods and marginally increased from 0.79 ± 0.27 cc/week/site in year three to 0.83 ± 0.4 cc/week/site during year four monitoring (Figure4). The marginal increase in feral predator activity is largely attributed to changes in cat activity which increased from 0.33 ± 27 cc/week/site in year three to 0.53 ± 0.4 cc/week/site during year four (Figure 5). Dog activity declined between years three and four, going from 0.19 ± 0.04 cc/week/site to 0.001 ± 0.001 cc/week/underpass, whereas fox has remained relatively unchanged (Figure 5).

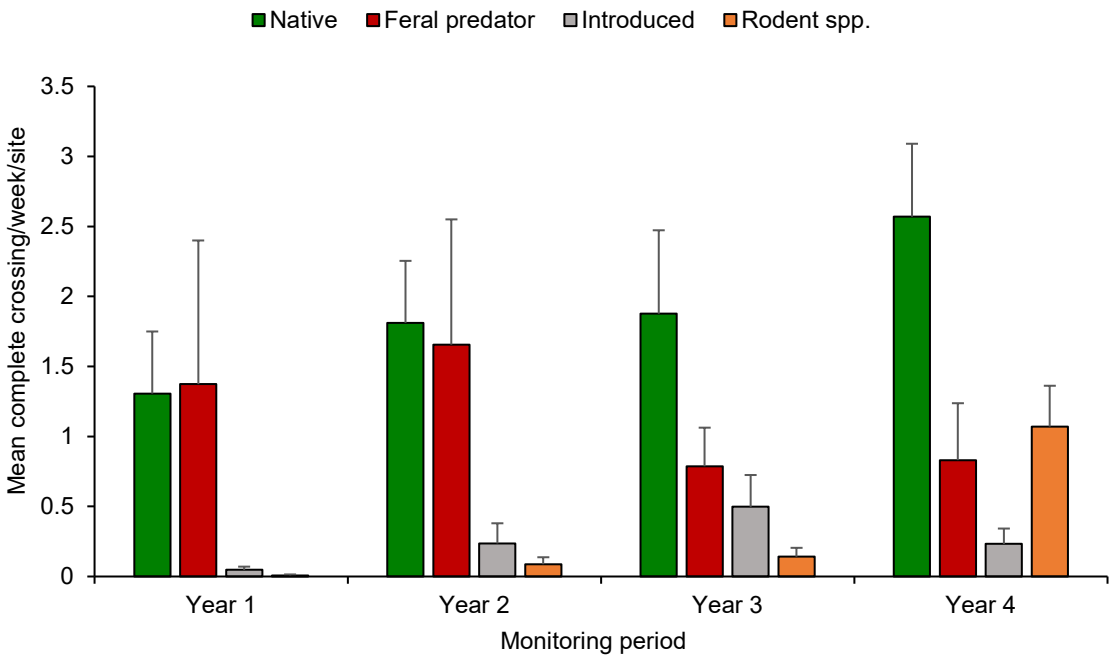

Figure 4: Mean number (n=9) of complete crossings/week/site (+SE) by native species, feral predators (cat dog and red fox) rodent spp. rodents (rodent spp. and *Rattus* spp.) and introduced species (European hare, black rat and house mouse) at WC2NH during operational monitoring, 2021-2022. Birds and microbats have been excluded.

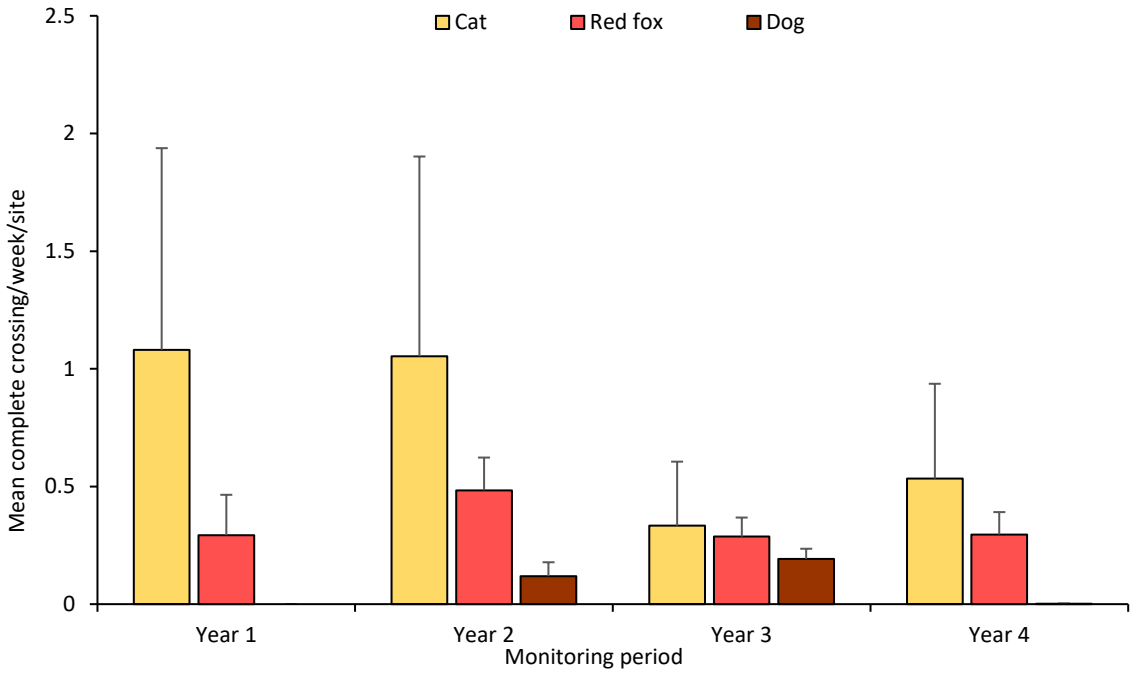

Figure 5: Mean number (n=9) of complete crossings/week/site (+SE) feral predators (cat dog and red fox) at WC2NH during operational monitoring, 2021-2022.

3.1.3 Sand pads

Eleven species and fauna groups were recorded on sand pads in year four operational monitoring (Appendix B, Table B2, Plate 5). Of the native species, swamp wallaby was the most frequently recorded fauna species, with tracks identified at sites 1, 2, 3, 4, 7, 8 and 9/10 (Appendix B, Table B2). Of the smaller cover-dependent fauna groups (i.e.,, small mammals, reptiles and amphibians), probable *Antechinus* spp. (sites 11/12, 9/10, 7, 8 and 5/6), probable frog (site 3 and 11/12) and medium lizard/skink (11/12) were recorded during inspections (Appendix B, Table B2). Other than the medium lizard and probable frog records, no species or groups were recorded in addition to those identified by cameras.

Plate 5: Bandicoot tracks (east and west) and bounding rodent tracks at site 8 during winter surveys (Left). Short-beaked echidna tracks heading east through the culvert at site 2 (Right).

3.1.4 Scat and track searches and tile checks

Seven species and seven fauna groups were recorded during scat and track surveys during year four monitoring of the WC2NH underpasses (Appendix B. Table B3). As seen in camera data, native species/fauna groups were found to be using all underpasses. The presence of feral predators (either cat, red fox or dog) was detected through tracks or scats at all underpasses with the exception of site 5/6 (Appendix B. Table B3). Records of small fauna not detected by cameras included tracks from medium lizard at 11/12 and scats from small/medium reptiles at sites 1,2,3,5/6, 9/10, and 11/12 (Appendix B. Table B3).

No fauna was recorded during tile checks (Appendix B, Table B4).

3.2 Adjacent habitat

Forty species/unique genera and six fauna groups were recorded in habitat adjoining underpasses during year four operational monitoring (Table 6). Most species/groups were detected by diurnal searches (25) and spotlighting (22) (Table 6, Appendix B, Table B5, and B6). Sixteen species were recorded during trapping, while hair funnels recorded four species and two groups (Appendix B Table B7, Table B8). Threatened species records included koala scat on the west side of sites 7 and 8 during active diurnal searches and giant barred frog on the east side of site 1 during spring/summer spotlight surveys (Table 6, Appendix B, Table B5 and B6).

Table 6: Detection of fauna species and groups during year four adjacent habitat monitoring at WC2NH, 2021-2022. Bold denotes threatened species. [I] = Introduced. Birds and sugar gliders have been excluded as they do not require underpasses for thoroughfare.

Species	Active Search	Spotlight	Trapping	Hair funnel
Mammals				
Brown antechinus			*	*
Antechinus spp.	*			*
Northern brown bandicoot			*	*
Long-nosed bandicoot		*	*	
Peramelidae spp. (bandicoot)	*			
Koala	*			
Common brushtail possum			*	
Short-eared brushtail possum	*		*	*
Common ringtail possum		*		
Trichosurus spp.	*			
Swamp wallaby	*	*		*
Wallaby spp.	*	*		
Eastern grey kangaroo	*			
Fawn-footed melomys		*	*	
Bush rat			*	*
Swamp rat			*	
Black rat [I]			*	
House mouse			*	
Rattus spp.	*	*		*
Red fox [I]	*			
Dog [I]	*	*		
Cat [I]	*			
Reptiles				
Lace monitor	*		*	
Eastern water dragon	*			
Calyptotis ruficauda	*	*	*	
Eastern crevice skink	*			
Lampropholis delicata	*	*	*	
Lampropholis guichenoti	*			
Lampropholis spp.	*			

Species	Active Search	Spotlight	Trapping	Hair funnel
Bandy bandy		*		
Yellow-faced whipsnake	*			
Red-bellied black snake	*			
Small-eyed snake		*		
Chelidae spp.				
Small reptile	*			
Frogs				
Litoria gracilenta		*		
Litoria fallax	*	*		
Litoria peronii		*		
Litoria caerulea		*		
Litoria tyleri		*		
Mixophyes iteratus		*		
Crinia signifera	*	*		
Adelotus brevis		*	*	
Uperoleia fusca		*		
Limnodynastes peronii	*	*	*	
Pseudophryne coriacea		*	*	
Total Nº· Species/groups	**25**	**22**	**16**	

3.2.1 Trapping

Twenty-three vertebrate fauna species have been captured during operational monitoring within habitat adjoining underpasses at WC2NH (Table 7). Mammals accounted for the majority of the fauna captured (545 individuals), followed by reptiles (66 individuals), frogs (16 individuals), and birds (3 individuals) (Table 7). Seventeen of the twenty-three species are cover-dependent, and three species captured were introduced, including black rat, house mouse, and cat (Table 7).

Overall captures have increased from 111 individuals in year one to 202 individuals in year four (Table 7). In order of the number of captured individuals, brown antechinus (149), fawn-footed melomys (135), bush rat (105), and black rat (81) have been the most frequently recorded species within the adjacent habitat, accounting for 75% of all captures (Table 7). Over time brown antechinus and bush rat captures have increased, with the highest number of individuals being captured during year four surveys (Table 7). Fawn-footed melomys initially increased from 16 individuals during year one surveys to 43 individuals in year three surveys before stabilising between 36 and 40 individuals in years three and four (Table 7). Black rat captures decreased from 20 and 26 individuals in years one and two of monitoring to 12 individuals in year three before increasing to 23 individuals in year four (Table 7).

Table 7: Temporal comparison of the number of fauna individuals and species recorded within the adjacent habitat at WC2NH during operational monitoring. [I] = Introduced. ^= cover dependent fauna.

Species	Year 1	Year 2	Year 3	Year 4	Total
Mammals					
Brown antechinus^	25	28	38	58	149
Sugar glider	1	6	8	5	20
Long-nosed bandicoot^				1	1
Fawn-footed melomys^	16	43	36	40	135
Northern brown bandicoot^	1	3	2	5	11
Short-eared brushtail possum	4	7	4	4	19
Common brushtail possum				1	1
Bush rat^	9	13	39	44	105
Swamp rat^			1		1
House mouse[I^]	7	7	6	1	21

Species	Year 1	Year 2	Year 3	Year 4	Total
Black rat[I^]	20	26	12	23	81
Cat[I]	1				1
Birds					
Eastern whipbird	1				1
Green catbird	1				1
Yellow-throated scrubwren		1			1
Reptiles					
Lace monitor			3	4	7
Blackish blind snake^	1	1			2
Dwarf-crowned snake^		1	2		3
Marsh snake^		2			2
*Calyptotis ruficauda^*	7	3	4	2	16
*Lampropholis delicata^*	9	3	9	11	32
*Lampropholis guichenoti^*	4				4
Frogs					
*Adelotus brevis^*				1	1
*Limnodynastes peronii^*	2	3			5
*Pseudophryne coriacea^*	2	4	2	2	10
Grand Total	111	151	166	202	630

3.2.2 Species recorded in underpasses and adjacent habitat

With the mentioned exclusions (see Table 8 caption), 43 vertebrate species and unique genera were confirmed within the adjacent habitat, with 24 using underpasses (Table 8). The proportion of species using underpasses from the adjacent habitat was 56% (Table 8). The proportion of mammals recorded in both adjacent habitat and underpasses was 95%, with the common ringtail possum being the only mammal species not recorded in underpasses (Table 8). Notably, a medium frog track was recorded on sand pads at site 11/12 during spring/summer monitoring. However, a species designation is not possible from tracks alone. Further, 12 reptile species/families were recorded during monitoring, with six (50%) confirmed using underpasses, including lace monitor, eastern blue-tongue lizard, eastern crevice skink, coastal carpet python, eastern water dragon, and *Chelidae spp.* (Freshwater turtle) (Table 8).

Table 8: Species and unique genera recorded in adjacent habitat and using underpasses during year four monitoring at WC2NH, 2021-2022. Due to duplication between species and fauna groups (e.g. wallaby spp. includes both red-necked and swamp wallaby), only confirmed species and unique genera have been included. Fauna in bold denotes threatened species. *Denotes presence. + = species designation assumed based on frequent capture of only brown antechinus in adjacent habitat. # = Species presence assumed due to detection in only the underpass. [I] = Introduced. ^= cover dependent fauna.

Species and unique genera	Underpass	Adjacent habitat
Mammals		
Short-beaked echidna	*	#
Brown antechinus ^	+	*
Northern brown bandicoot^	*	*
Long-nosed bandicoot^	*	*
Koala	*	*
Short-eared brushtail possum	*	*
Common brushtail possum	*	*
Common ringtail possum		*
Swamp wallaby	*	*
Red-necked wallaby	*	#
Eastern grey kangaroo	*	*
Water rat	*	#
Fawn-footed melomys^	*	*

Species and unique genera	Underpass	Adjacent habitat
Black rat^[I]	*	*
Red fox[I]	*	*
Cat[I]	*	#
Dog[I]	*	*
House mouse^[I]	*	*
European Hare	*	#
Sub-total mammals	**18**	**19**
Reptiles		
Lace monitor	*	*
Eastern water dragon	*	*
Eastern crevice skink^	*	*
Coastal carpet python	*	#
Eastern blue tongued lizard^	*	#
Calyptotis ruficauda ^		*
Lampropholis delicata ^		*
Lampropholis guichenoti ^		*
Bandy bandy ^		*
Yellow-faced whipsnake ^		*
Small-eyed snake^		*
Red-bellied black snake		*
Chelidae spp.	*	#
Sub-total reptiles	**6**	**13**
Frogs		
*Litoria gracilenta^*		*
Litoria fallax ^		*
Litoria peronii ^		*
*Litoria caerulea^*		*
*Litoria tyleri^*		*
Mixophyes iteratus^		*
*Crinia signifera^*		*
Adelotus brevis ^		*
*Uperoleia fusca^*		*
Pseudophryne coriacea ^		*
Limnodynastes peronii		*
Sub-total frogs	**0**	**11**
Total Nº. Species/unique genera	**24**	**43**

4. Discussion

4.1 Low rates of use of fauna underpasses and adjacent habitats by feral predators

A definition of "low use" by feral predators is not provided in the WC2NH EMP (RMS 2018). Cat, red fox and dog were recorded across seven of the nine underpass sites at an overall rate of 0.83 ± 0.4 cc/week/site and accounted for 18% of complete crossings during year four monitoring. This represents a decrease in comparison to years one and two, where feral predators accounted for ~ 50% of complete crossings (Sandpiper Ecological 2019, 2020).

In particular, dog records have decreased by ~99% from year 3 (0.19 ± 0.04cc/week/site) to year 4 (0.001 ± 0.001 cc/week/site), when only one individual was recorded once at site 11/12. The decline in wild dog records can be attributed to the success of the collaborative trapping program completed at WC2NH during the

autumn of 2021 that removed an individual that frequented the underpass sites (Saltair Flora and Fauna 2021). Wild dogs tend to occupy large home ranges in south-eastern Australia, of between 10,000 and 39 000 hectares (Claridge et al. 2009). Given that the individual at 11/12 was recorded on one occasion and not re-recorded, the individual may be passing through its home range. Monitoring in year five will determine whether further action is warranted, as wild dogs are a known predator of koalas particularly where habitat occurs near residential areas (Gentle *et al.* 2019).

Fox activity initially increased between years one and two of monitoring before declining in year three following the collaborative trapping program and removal of six individuals caught at the culvert entrances (Saltair Flora and Fauna 2021). Since trapping, fox activity has slightly increased between year three (0.29 ± 0.08 cc/week/underpass) and four (0.30 ± 0.09 cc/week/underpass). The slight increase in fox detection despite the removal of six individuals is likely related to improved breeding success and abundance associated with a combination of favourable climatic conditions in year four (high rainfall) and an associated higher abundance of prey items as well lower dog activity (Johnson and Vanderwal 2009). Fox activity is anticipated to increase in year five monitoring. The magnitude of the increase in fox activity in the spring/summer year five surveys will assist in determining whether further control is warranted.

Cat activity has increased from 0.33 ± 27 cc/week/site in year three to 0.53 ± 0.4 cc/week/site, with continued high use at site 3, where a resident cat has been recorded consistently throughout operational monitoring (Sandpiper 2021b). The reason/s for this are unclear but may be associated with lower dog activity, although this is contrary to published studies on the relationship between wild dogs and cats (Fancourt *et al.* 2019; Kreplins *et al.* 2020). As discussed for red fox, it is likely related to the favourable climatic conditions and the associated increase in prey. Removal of the individual at site three would greatly reduce the rate of underpass use by cats at WC2NH. Targeted cage trapping in years two, three and four failed to capture the individual. During the year five surveys cage trapping using alternative baits and 'free feeding' will be continued.

Interestingly, site 7 has not recorded feral predators during either year three or four. However, scat and track searches during year four identified both fox and cat prints in the entrances of the structure. Site 7 has a particularly wet/muddy ground surface throughout the underpass, which may deter feral predators such as cat and fox to some extent.

4.2 High levels of fauna underpass use by a variety of native species

A wide variety (24) of native species and unique genera were recorded using underpasses. Of the 43 species recorded in the adjacent habitat, 57% were recorded using underpasses. The proportion of species using underpasses is encouraging with a higher percentage of species using underpasses than at Sapphire to Woolgoolga (23% to 50%), and comparable to findings at the adjacent Nambucca Heads to Urunga (NH2U, 58%) (Sandpiper Ecological 2018 and 2022). Encouragingly, 95% of the mammals and nearly 50% of the reptiles recorded in the adjacent habitat were found to be using underpasses during year four monitoring. The WC2NH monitoring project observed no usage of underpasses by the eleven frog species in the adjacent habitat, consistent with the NH2U project. However, a single frog track was detected at site 11/12, suggesting some utilisation by certain species. Limited detection may be due to camera trap constraints rather than avoidance behaviour, indicating that more frogs may be using the underpasses.

Camera monitoring has provided further evidence of a temporal increase in underpass use by native species, which has increased from 1.87 cc/week/site to 2.57 cc/week/site or around ~58% between year three and year four of monitoring (Sandpiper Ecological 2021a). The result is not unexpected as use by native fauna is expected to increase over time as site features improve, a trend also recorded at Sapphire to Woolgoolga and recent monitoring at Nambucca Heads to Urunga (Sandpiper Ecological 2018, 2022). Improved weather conditions may have been attributed to the temporal increase with prevailing La Niña conditions experienced between early 2020 and August 2022, providing favourable conditions for improved breeding success for most

native species. The increased number of small mammal captures (particularly brown antechinus and bush rat) during year four monitoring also suggests an increase in breeding success, hence contributing to higher underpass use. Further, vegetation around the culvert entrances has greatly improved (L. Andrews pers obs) in the previous year, likely further encouraging underpass use.

Koalas continue to use underpasses at WC2NH in year four of the operational phase, with individuals recorded making complete crossings on the culvert floor (ground) at sites 2 (one occasion), 4 (two occasions Plate 4) and 11/12 (two occasions). Encouragingly, site 2 has not previously recorded use by koalas and now brings the total number of underpasses used during operational monitoring to six out of nine underpasses or 66% of all sites monitored.

One notable feature of monitoring is the variation in the species richness and level of fauna use between sites at WC2NH. Location seems to be a key feature in determining native fauna use at WC2NH, with higher diversity seeming to occur where culvert entrances adjoin dense ground cover or around creeks and drainage lines. Site features are also likely to play a role in determining underpass use by native species. For instance, site 5/6 at WC2NH typically records low use by native fauna due to adjoining fragmented landscape on the western side of the culvert and pooling of water in the wet passage (culvert 5) side of the culvert. Further monitoring is required to enable a comparison of site features and locations considered optimal for underpass use by native species. At the completion of year five monitoring, a more robust dataset would be available to explore this concept further.

4.3 No change to densities, distribution, habitat use, and movement patterns compared to baseline population data of target species.

The target species for underpass monitoring, as outlined in the EMP, are spotted-tailed quoll, koala and giant barred frog. No spotted-tailed quolls have been detected to date, consistent with baseline monitoring (GeoLink 2014), and population monitoring of giant barred frogs at Upper Warrell Creek is addressed by Sandpiper Ecological (2021b). Koala records at sites 2, 4 and 11/12 in year four show that koalas continue to use underpasses to access habitat on both sides of the alignment.

4.4 Evidence of use by dispersing individuals and different age cohorts

Accurately confirming the age of individuals using underpasses is difficult using the survey methods outlined in the EMP.
Other methods such as mark-release-recapture would likely be required to provide definitive proof of use by dispersing individuals and different age cohorts. Such a survey is not warranted at WC2NH.

4.5 Use by cover-dependent species with low mobility

Several native cover-dependent species (typically small mammals, small reptiles and frogs) were recorded in adjacent habitat, including eleven frog species, four native mammals (brown antechinus, swamp rat, fawn-footed melomys and bush rat) and eight reptile species. Of these, four cover-dependent species (*Antechinus* spp, fawn-footed melomys, eastern blue-tongue lizard and eastern crevice skink) were recorded using underpasses. Encouragingly, a new cover-dependent species, the eastern blue-tongue lizard, was recorded using a culvert to cross the alignment at site 11/12. Consistent with previous surveys, there were limited records of frogs and reptiles in underpasses. The low occurrence of frogs and reptiles is most likely due to the inability of cameras to detect these species as opposed to avoidance. The use of sand pads and scat and track searches cover this shortfall, with records of medium reptiles and a medium frog being recorded at site 11/12.

Tile checks have proved ineffective at detecting cover-depended fauna with no records since their implementation in 2020.

5. Contingency Measures and Recommendations

5.1 Contingency Measures

Contingency measures are summarised in Table 9.

Table 9: Potential problems outlined in the EMP and possible contingency measures. Proposed mitigation measures applicable to the project are addressed in bold text.

Problem	Contingency/Corrective Action	Proposed action
High rates of feral predator activity;	Control program	No action. Fox activity remains equivocal to year three monitoring, and dog activity has declined. Fox and dog visitation in year 5 spring/summer monitoring will be used to determine if further control is warranted.
Low levels of native fauna movement and species diversity in underpasses;	Modify habitat structure near underpass entrances and/or modify underpass fauna furniture	No action is required – monitoring has shown that fauna furniture is functional and underpasses provide safe passage for 95% of mammal species recorded in adjacent habitats.
No use of underpasses by cover-dependent species or species with low mobility or target threatened species	Modify or add potential groundcover resources	Six native cover-dependent species and one threatened species (koala) were recorded using underpasses on several occasions. Tiles have proved ineffective at detecting cover-dependent fauna. No further action is warranted.
High rates of fauna road mortality.	Modify exclusion fencing design, location or extent depending on the species and location of mortalities	Issues relating to road mortality are addressed in the quarterly and annual road-kill reports. At this stage no modifications to the location or extent of exclusion fence is proposed. No mortality of target species has been recorded during the monitoring program.

5.2 Recommendations

Recommendations are summarised in Table 10.

Table 10: Recommendations based on findings from year four operational phase monitoring and response from TfNSW.

Number	Recommendation	Transport for NSW Response
1.	Monitor dog and fox activity during the year 5 spring/summer sample and use the data collected to determine if control is warranted	Noted.

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Appendix A – Species list

Table A1: Common and scientific names for all species recorded during operational monitoring at WC2NH. Species in bold = Threatened species.

Common Name	Scientific Name
Mammals	
Koala	*Phascolarctos cinereus*
Swamp wallaby	*Wallabia bicolor*
Red-necked wallaby	*Macropus rufogriseus*
Wallaby spp.	
Short-beaked echidna	*Tachyglossus aculeatus*
Yellow-bellied glider	*Petaurus australis*
Sugar glider	*Petaurus breviceps*
	Petaurus spp.
Short-eared brushtail possum	*Trichosurus caninus*
Common brushtail possum	*Trichosurus vulpecula*
Brushtail possum spp.	*Trichosurus spp.*
Common ringtail possum	*Pseudocheirus peregrinus*
Northern brown bandicoot	*Isoodon macrourus*
Long-nosed bandicoot	*Perameles nasuta*
Bandicoot species	*Peramelidae spp.*
Fawn-footed melomys	*Melomys cervinipes*
	Melomys spp.
Water rat	*Hydromys chrysogaster*
Bush rat	*Rattus fuscipes*
Swamp rat	*Rattus lutreolus*
Brown antechinus	*Antechinus stuartii*
	Antechinus spp.
Grey-headed flying red fox	*Pteropus poliocephalus*
Flying red fox spp.	*Pteropus spp.*
Bent-wing spp.	*Miniopterus spp.*
Small mammal spp.	
	Dasyuridae spp.
Reptiles	
Eastern crevice skink	*Egernia mcpheii*
Garden skink	*Lampropholis delicata*
Grass skink	*Lampropholis guichenoti*
	Lampropholis spp.
Red-tailed calyptotis	*Calyptotis ruficauda*
Eastern water-skink	*Eulamprus quoyii*
Three-toed skink	*Saiphos equalis*
Skink spp.	*Scincidae spp.*
Coastal carpet python	*Morelia spilota*
Red-bellied black snake	*Pseudechis porphyriacus*
Yellow-faced whipsnake	*Demansia psammophis*
Black-bellied swamp snake	*Hemiaspis signata*
Blackish blind snake	*Anilios nigrescens*
Bandy bandy	*Vermicella annulata*
Coastal carpet python	*Morelia spilota*
Burton's legless lizard	*Lialis burtonis*
Lace monitor	*Varanus varius*
Eastern water dragon	*Intellagama lesueurii*
	Agamid spp.
Freshwater turtle spp.	*Chelidae spp.*

Common Name	Scientific Name
Frogs	
Eastern dwarf tree frog	*Litoria fallax*
Tyler's tree frog	*Litoria tyleri*
Red-eyed tree frog	*Litoria chloris*
Green tree frog	*Litoria cerulea*
Dusky toadlet	*Uperolia fusca*
Tusked frog	*Adelotus brevis*
Common eastern froglet	*Crinia signifera*
Giant barred frog	*Mixophyes iteratus*
Striped marsh frog	*Limnodynastes peronii*
Red-backed toadlet	*Pseudophryne coriacea*
Medium frog spp.	
Introduced	
Cat	*Felis catus*
Red fox	*Vulpes vulpes*
Black rat	*Rattus rattus*
European hare	*Lepus europaeus*
House mouse	*Mus musculus*

Appendix B – Field data

Table B1: Underpass camera data recorded during spring/summer and winter of year four operational monitoring WC2NH, 2021-2022.

Season	Site	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM	Comments
Spring/Summer	1	North	nil			0			
Spring/Summer	1	South	Swamp wallaby	Native	Macropod	1		1	
Spring/Summer	2	Furniture	Antechinus spp.	Native	Antechinus	17	3		
Spring/Summer	2	Furniture	Eastern crevice skink	Native	Lizard	2	4		
Spring/Summer	2	Furniture	Lizard spp.		Lizard	1			
Spring/Summer	2	Furniture	Rodent spp.	Undefined	Rodent	22	7		
Spring/Summer	2	Ground	Bandicoot spp.	Native	Bandicoot	7			
Spring/Summer	2	Ground	Cat	Introduced	Feral predator	1			
Spring/Summer	2	Ground	Microbat spp.			0		1	
Spring/Summer	2	Ground	Red fox	Introduced	Feral predator	8			
Spring/Summer	2	Ground	Rodent spp.	Undefined	Rodent	2	1		
Spring/Summer	2	Ground	Swamp wallaby	Native	Macropod	3	1	1	
Spring/Summer	2	Ground	Trichosurus spp.	Native	Possum	2			
Spring/Summer	2	Ground	turtle spp.			1			
Spring/Summer	2	Ground	Wallaby spp.	Native	Macropod	22			
Spring/Summer	3	Furniture	Cat	Introduced	Feral predator	9			
Spring/Summer	3	Furniture	Lizard spp.			1			
Spring/Summer	3	Furniture	Microbat spp.			0		1	
Spring/Summer	3	Furniture	Short-eared brushtail possum	Native	Possum	0	1		
Spring/Summer	3	Furniture	Trichosurus spp.	Native	Possum	2			
Spring/Summer	3	Furniture	Welcome swallow	0	Bird	0		1	
Spring/Summer	3	Furniture	Welcome swallow	0	Bird	0			
Spring/Summer	3	Ground	Bandicoot spp.	Native	Bandicoot	6			
Spring/Summer	3	Ground	Cat	Introduced	Feral predator	34	2		
Spring/Summer	3	Ground	Eastern grey kangeroo	Native	Macropod	27			
Spring/Summer	3	Ground	Eastern water dragon	Native	Lizard	0	1		
Spring/Summer	3	Ground	Lace monitor	Native	Lizard	2			
Spring/Summer	3	Ground	Long-nosed bandicoot	Native	Bandicoot	1			
Spring/Summer	3	Ground	Microbat spp.			0		1	

Season	Site	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM	Comments
Spring/Summer	3	Ground	Northern brown bandicoot	Native	Bandicoot	1			
Spring/Summer	3	Ground	Red fox	Introduced	Feral predator	2			
Spring/Summer	3	Ground	Rodent spp.	Undefined	Rodent	1			
Spring/Summer	3	Ground	Swamp wallaby	Native	Macropod	1		1	
Spring/Summer	3	Ground	Wallaby spp.	Native	Macropod	17			
Spring/Summer	4	Furniture	Lace monitor	Native	Lizard	3			
Spring/Summer	4	Furniture	Rodent spp.	Undefined	Rodent	11			
Spring/Summer	4	Furniture	Short-eared brushtail possum	Native	Possum	26	2		
Spring/Summer	4	Ground	Bandicoot spp.	Native	Bandicoot	3			
Spring/Summer	4	Ground	Eastern water dragon	Native	Lizard	1			
Spring/Summer	4	Ground	Koala	Native	Koala	1			
Spring/Summer	4	Ground	Red fox	Introduced	Feral predator	3			
Spring/Summer	4	Ground	Rodent spp.	Undefined	Rodent	4			
Spring/Summer	4	Ground	Short-eared brushtail possum	Native	Possum	1			
Spring/Summer	4	Ground	Swamp wallaby	Native	Macropod	10	1		
Spring/Summer	5	North	Bandicoot spp.	Native	Bandicoot	2			
Spring/Summer	5	North	Rodent spp.	Undefined	Rodent	3			
Spring/Summer	5	South	Microbat spp.			0		1	
Spring/Summer	5	South	Northern brown bandicoot	Native	Bandicoot	1		1	
Spring/Summer	5	South	Rodent spp.	Undefined	Rodent	2			
Spring/Summer	5	South	water rat	Native	Native rodent	3			
Spring/Summer	6	Furniture	Antechinus spp.	Native	Antechinus	11	5		
Spring/Summer	6	Furniture	Lace monitor	Native	Lizard	0	1		
Spring/Summer	6	Furniture	Microbat spp.			0		1	
Spring/Summer	6	Furniture	Rodent spp.	Undefined	Rodent	6			
Spring/Summer	6	Furniture	Short-eared brushtail possum	Native	Possum	5			
Spring/Summer	6	Ground	Bandicoot spp.	Native	Bandicoot	5	1		
Spring/Summer	6	Ground	Cat	Introduced	Feral predator	2			
Spring/Summer	6	Ground	Lace monitor	Native	Lizard	4			
Spring/Summer	6	Ground	Long-nosed bandicoot	Native	Bandicoot	9	2		
Spring/Summer	6	Ground	Red fox	Introduced	Feral predator	4	1		
Spring/Summer	6	Ground	wonga pigeon			5			
Spring/Summer	7	Furniture	black rat	Introduced	Introduced rodent	4	2		

Season	Site	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM	Comments
Spring/Summer	7	Furniture	Coastal carpet python			1			
Spring/Summer	7	Furniture	Eastern crevice skink	Native	Lizard	1			
Spring/Summer	7	Furniture	Lace monitor	Native	Lizard	5			
Spring/Summer	7	Furniture	Microbat spp.			0		1	
Spring/Summer	7	Furniture	Rodent spp.	Undefined	Rodent	9			
Spring/Summer	7	Furniture	Short-eared brushtail possum	Native	Possum	58	2		
Spring/Summer	7	Ground	Bandicoot spp.	Native	Bandicoot	10	1		
Spring/Summer	7	Ground	black rat	Introduced	Introduced rodent	8			
Spring/Summer	7	Ground	Lace monitor	Native	Lizard	6			
Spring/Summer	7	Ground	Rodent spp.	Undefined	Rodent	8			
Spring/Summer	7	Ground	Short-eared brushtail possum	Native	Possum	1			
Spring/Summer	7	Ground	Swamp wallaby	Native	Macropod	4			
Spring/Summer	7	Ground	Wallaby spp.	Native	Macropod	11			
Spring/Summer	8	Furniture	Antechinus spp.	Native	Antechinus	1	1		
Spring/Summer	8	Furniture	Cat	Introduced	Feral predator	11	4		
Spring/Summer	8	Furniture	Eastern crevice skink	Native	Lizard	1			
Spring/Summer	8	Furniture	Microbat spp.			0		1	
Spring/Summer	8	Furniture	Rodent spp.	Undefined	Rodent	90	8		
Spring/Summer	8	Furniture	Short-eared brushtail possum	Native	Possum	34			
Spring/Summer	8	Ground	Bandicoot spp.	Native	Bandicoot	13			
Spring/Summer	8	Ground	Cat	Introduced	Feral predator	17			
Spring/Summer	8	Ground	Lace monitor	Native	Lizard	7			
Spring/Summer	8	Ground	Red fox	Introduced	Feral predator	13	1		
Spring/Summer	8	Ground	Short-eared brushtail possum	Native	Possum	0	2		
Spring/Summer	8	Ground	Swamp wallaby	Native	Macropod	8			
Spring/Summer	8	Ground	Wallaby spp.	Native	Macropod	19			
Spring/Summer	9	Furniture	Eastern crevice skink	Native	Lizard	1			
Spring/Summer	9	Furniture	Short-eared brushtail possum	Native	Possum	2			
Spring/Summer	9	Ground	Bandicoot spp.	Native	Bandicoot	21	1		
Spring/Summer	9	Ground	black rat	Introduced	Introduced rodent	6			
Spring/Summer	9	Ground	Cat	Introduced	Feral predator	2	1		

Season	Site	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM	Comments
Spring/Summer	9	Ground	Eastern blue tongued lizard			2			
Spring/Summer	9	Ground	Lace monitor	Native	Lizard	2			
Spring/Summer	9	Ground	Long-nosed bandicoot	Native	Bandicoot	5			
Spring/Summer	9	Ground	Red fox	Introduced	Feral predator	7	1		
Spring/Summer	9	Ground	Rodent spp.	Undefined	Rodent	40	4		
Spring/Summer	9	Ground	Short-beaked echidna	Native	Echidna	2			
Spring/Summer	9	Ground	snake spp.			0			
Spring/Summer	9	Ground	Trichosurus spp.	Native	Possum	6			
Spring/Summer	9	Ground	Wonga pigeon			21	2		
Spring/Summer	10	Furniture	Antechinus spp.	Native	Antechinus	9	1		
Spring/Summer	10	Furniture	Black rat	Introduced	Introduced rodent	2			
Spring/Summer	10	Furniture	Eastern crevice skink	Native	Lizard	7	5		
Spring/Summer	10	Furniture	Fawn-footed melomys	Native	Native rodent	1			
Spring/Summer	10	Furniture	Lace monitor	Native	Lizard	1			
Spring/Summer	10	Furniture	Rodent spp.	Undefined	Rodent	7	3		
Spring/Summer	10	Furniture	Short-eared brushtail possum	Native	Possum	22			
Spring/Summer	10	Furniture	Trichosurus spp.	Native	Possum	7			
Spring/Summer	10	Ground	Bandicoot spp.	Native	Bandicoot	11			
Spring/Summer	10	Ground	Black rat	Introduced	Introduced rodent	1			
Spring/Summer	10	Ground	Cat	Introduced	Feral predator	2	1		
Spring/Summer	10	Ground	Lace monitor	Native	Lizard	2			
Spring/Summer	10	Ground	Long-nosed bandicoot	Native	Bandicoot	2	2		
Spring/Summer	10	Ground	Red fox	Introduced	Feral predator	6			
Spring/Summer	10	Ground	Rodent spp.	Undefined	Rodent	3			
Spring/Summer	10	Ground	Short-beaked echidna	Native	Echidna	1			
Spring/Summer	10	Ground	Swamp wallaby	Native	Macropod	0	1		
Spring/Summer	10	Ground	Trichosurus spp.	Native	Possum	1			
Spring/Summer	10	Ground	Wonga pigeon			1			
Spring/Summer	11	Furniture	Antechinus spp.	Native	Antechinus	1			
Spring/Summer	11	Furniture	Eastern crevice skink	Native	Lizard	2			
Spring/Summer	11	Furniture	Rodent spp.	Undefined	Rodent	31	5		

Season	Site	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM	Comments
Spring/Summer	11	Furniture	Short-eared brushtail possum	Native	Possum	5			
Spring/Summer	11	Furniture	Trichosurus spp.	Native	Possum	3			
Spring/Summer	11	Ground	Bandicoot spp.	Native	Bandicoot	4			
Spring/Summer	11	Ground	Cat	Introduced	Feral predator	1			
Spring/Summer	11	Ground	Northern brown bandicoot	Native	Bandicoot	1			
Spring/Summer	11	Ground	Red fox	Introduced	Feral predator	7			
Spring/Summer	11	Ground	snake spp.			0	1		
Spring/Summer	11	Ground	Wallaby spp.	Native	Macropod	1			
Spring/Summer	12	Furniture	Antechinus spp.	Native	Antechinus	3			
Spring/Summer	12	Furniture	Eastern crevice skink	Native	Lizard	1			
Spring/Summer	12	Furniture	Rodent spp.	Undefined	Rodent	0	2		
Spring/Summer	12	Furniture	Short-eared brushtail possum	Native	Possum	2			
Spring/Summer	12	Furniture	Trichosurus spp.	Native	Possum	20			
Spring/Summer	12	Ground	Bandicoot spp.	Native	Bandicoot	29			
Spring/Summer	12	Ground	Cat	Introduced	Feral predator	2			
Spring/Summer	12	Ground	Lace monitor	Native	Lizard	1			
Spring/Summer	12	Ground	Long-nosed bandicoot	Native	Bandicoot	27			
Spring/Summer	12	Ground	Northern brown bandicoot	Native	Bandicoot	16	2		
Spring/Summer	12	Ground	Red fox	Introduced	Feral predator	12			
Spring/Summer	12	Ground	Rodent spp.	Undefined	Rodent	3			
Spring/Summer	12	Ground	Swamp wallaby	Native	Macropod	1			
Winter	1	North	Swamp wallaby	Native	Macropod	1			
Winter	1	North	House mouse	Introduced	Introduced rodent	1			
Winter	1	North	Antechinus spp.	Native	Antechinus	2			Obscured vision/mud from flood
Winter	1	South	Nil	Nil	Nil	Nil	Nil	Nil	Obscured vision/mud from flood
Winter	2	Furniture	Fawn-footed Melomys	Native	Native rodent	1			
Winter	2	Furniture	Rattus spp.	Undefined	Rodent	10	1		
Winter	2	Furniture	Antechinus spp.	Native	Antechinus	11	2	1	
Winter	2	Ground	Rodent spp.	Undefined	Rodent	1			
Winter	2	Ground	Bandicoot spp.	Native	Bandicoot	12			
Winter	2	Ground	Koala	Native	Koala	1			Heading east 8/7/22 2314
Winter	2	Ground	Swamp wallaby	Native	Macropod	11	2	1	
Winter	2	Ground	Wallaby spp.	Native	Macropod	4			
Winter	2	Ground	Red fox	Introduced	Feral predator	5	1		

Season	Site	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM	Comments
Winter	2	Ground	Cat	Introduced	Feral predator	1			
Winter	3	Furniture	Welcome sparrow			2	5	15	
Winter	3	Furniture	Microbat spp.					2	
Winter	3	Furniture	Short-eared brushtail possum	Native	Possum	2			
Winter	3	Furniture	Cat	Introduced	Feral predator				
Winter	3	Furniture	Possum spp.	Native	Possum			1	
Winter	3	Ground	Cat	Introduced	Feral predator	96	3	4	1 w/ collar (stripes) 1 with white patch under head and white socks carrying ante/rodent spp in mouth (68)
Winter	3	Ground	Rodent spp.	Undefined	Rodent	2			
Winter	3	Ground	Wallaby spp.	Native	Macropod	1			
Winter	3	Ground	Eastern grey kangeroo	Native	Macropod	2			
Winter	3	Ground	Red-necked wallaby	Native	Macropod	1			
Winter	3	Ground	Red fox	Introduced	Feral predator	4			
Winter	3	Ground	Swamp wallaby	Native	Macropod	3			
Winter	4	Furniture	Black rat	Intoduced	Rodent	22	4	1	
Winter	4	Furniture	Possum spp.	Native	Possum	7	1		
Winter	4	Furniture	Rodent spp.	Undefined	Rodent	35	3		
Winter	4	Furniture	Antechinus spp.	Native	Antechinus	2			
Winter	4	Furniture	Short-eared brushtail possum	Native	Possum	8	4		
Winter	4	Ground	Swamp wallaby	Native	Macropod	21	1	1	Can't see anything at night (no night mode/flash?)
Winter	4	Ground	Koala	Native	Koala	1			7/7//22, 1924 heading east
Winter	4	Ground	Bandicoot spp.	Native	Bandicoot	9			
Winter	4	Ground	Short-eared brushtail possum	Native	Possum	1			
Winter	4	Ground	Fox	Introduced	Feral predator	1			
Winter	4	Ground	Cat	Introduced	Feral predator	2			
Winter	5	North	Water rat	Native	Native rodent	3	1		
Winter	5	North	Long-nosed bandicoot	Native	Bandicoot	1			
Winter	5	North	Bandicoot spp.	Native	Bandicoot	1			
Winter	5	North	Rodent spp.	Undefined	Rodent	1			
Winter	5	South	Water rat	Native	Native rodent	5	1		
Winter	5	South	Rattus spp.	Undefined	Rodent	3	1		
Winter	5	North	Water rat	Native	Native rodent	3			
Winter	6	Furniture	Black rat	Introduced	Rodent	8	1		

Season	Site	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM	Comments
Winter	6	Furniture	Rodent spp.	Undefined	Rodent	42	5		
Winter	6	Furniture	Microbat spp.					2	
Winter	6	Furniture	Fawn-footed Melomys	Native	Native rodent	2			
Winter	6	Ground	Fox	Introduced	Feral predator	7			
Winter	6	Ground	Bandicoot spp.	Native	Bandicoot	2			
Winter	6	Ground	Short-beaked Echidna	Native	Echidna	2			
Winter	6	Ground	Cat	Introduced	Feral predator	2			
Winter	6	Ground	Long-nosed bandicoot	Native	Bandicoot	7	1		
Winter	6	Ground	European Hare	Introduced	Hare	4			
Winter	7	Furniture	Black rat	Introduced	Introduced rodent	12	3		
Winter	7	Furniture	Rodent spp.	Undefined	Rodent	27			
Winter	7	Furniture	Possum spp.	Native	Possum	4			
Winter	7	Furniture	Antechinus spp.	Native	Antechinus	26	4		
Winter	7	Furniture	Short-eared brushtail possum	Native	Possum	8			
Winter	7	Furniture	Fawn-footed Melomys	Native	Native rodent	3			
Winter	7	Ground	Bandicoot spp.	Native	Bandicoot	12			
Winter	7	Ground	Long-nosed bandicoot	Native	Bandicoot	7			
Winter	7	Ground	Northern brown bandicoot	Native	Bandicoot	2			
Winter	7	Ground	Swamp wallaby	Native	Macropod	5	2		
Winter	7	Ground	Possum spp.	Native	Possum	1			
Winter	7	Ground	Wallaby spp.	Native	Macropod	1			
Winter	7	Ground	Rodent spp.	Undefined	Rodent	3			
Winter	8	Furniture	Possum spp.	Native	Possum	7	2		
Winter	8	Furniture	Rodent spp.	Undefined	Rodent	13			
Winter	8	Furniture	Black rat	Introduced	Introduced rodent	2			
Winter	8	Furniture	Fawn-footed Melomys	Native	Melomys	1			
Winter	8	Furniture	Microbat spp.				2		
Winter	8	Furniture	Antechinus spp.	Native	Antechinus	22	4		
Winter	8	Ground	Bandicoot spp.	Native	Bandicoot	3			
Winter	8	Ground	Swamp wallaby	Native	Macropod	21			
Winter	8	Ground	Wallaby spp.	Native	Macropod	4			
Winter	8	Ground	Fox	Introduced	Feral predator	10			

Season	Site	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM	Comments
Winter	8	Ground	Northern brown bandicoot	Native	Bandicoot	3			
Winter	8	Ground	Long-nosed bandicoot	Native	Bandicoot	4			
Winter	8	Ground	cat	Introduced	Cat	2			
Winter	8	Ground	Short-beaked Echidna	Native	Echidna	1			
Winter	8	Ground	European Hare	Introduced	Hare	1			
Winter	9	Furniture	Short-eared brushtail possum	Native	Possum	1			
Winter	9	Furniture	Brown antechinus	Native	Antechinus	4			
Winter	9	Furniture	Cat	Introduced	Feral predator		1		
Winter	9	Ground	Wallaby spp.	Native	Macropod	1			
Winter	9	Ground	Red fox	Introduced	Feral predator	3			
Winter	9	Ground	Swamp wallaby	Native	Macropod		1		
Winter	9	Ground	Microbat spp.			1			
Winter	9	Ground	Short-eared brushtail possum	Native	Possum	1			
Winter	9	Ground	Bandicoot spp.	Native	Bandicoot	2			
Winter	10	Furniture	Rodent spp.	Undefined	Rodent	22	1		
Winter	10	Furniture	Black rat	Introduced	Rodent	3			
Winter	10	Furniture	Bush rat	Native	Native rodent	2			
Winter	10	Furniture	Antechinus spp.	Native	Antechinus	11			
Winter	10	Furniture	Fawn-footed Melomys	Native	Melomys	2	1		
Winter	10	Furniture	Possum spp.	Native	Possum		2		
Winter	10	Furniture	Short-eared brushtail possum	Native	Possum	1			
Winter	10	Ground	Swamp wallaby	Native	Macropod	3			
Winter	10	Ground	Red fox	Introduced	Feral predator	8	1		
Winter	10	Ground	Bandicoot spp.	Native	Bandicoot	2			
Winter	10	Ground	Long-nosed bandicoot	Native	Bandicoot	3			
Winter	10	Ground	Antechinus spp.	Native	Antechinus	2			
Winter	10	Ground	Short-beaked Echidna	Native	Echidna	1			
Winter	10	Ground	Possum spp.	Native	Possum	1			
Winter	11	Furniture	Short-eared brushtail possum	Native	Possum	7			
Winter	11	Ground	Red fox	Introduced	Feral predator	28	1		
Winter	11	Ground	Wallaby spp.	Native	Macropod	1			
Winter	11	Ground	Bandicoot spp.	Native	Bandicoot	2			

Season	Site	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM	Comments
Winter	11	Ground	Koala	Native	Koala	1			
Winter	11	Ground	Cat	Introduced	Feral predator	1			
Winter	11	Ground	Long-nosed bandicoot	Native	Bandicoot	4			
Winter	11	Ground	Short-eared brushtail possum	Native	Possum	2			
Winter	11	Ground	European rabbit	Introduced	Hare	1			
Winter	11	Ground	Short-beaked Echidna	Native	Echidna	1			
Winter	12	Furniture	Short-eared brushtail possum	Native	Possum	9			
Winter	12	Furniture	Common brushtail possum	Native	Possum	1			
Winter	12	Furniture	Possum spp.	Native	Possum	1			
Winter	12	Furniture	Rattus spp.	Undefined	Rodent	1			
Winter	12	Ground	Red fox	Introduced	Feral predator	13			
Winter	12	Ground	Wallaby spp.	Native	Macropod	1			
Winter	12	Ground	Bandicoot spp.	Native	Bandicoot	4			
Winter	12	Ground	Loong-nosed bandicoot	Native	Bandicoot	1			
Winter	12	Ground	Rodent spp.	Undefined	Rodent	1			
Winter	12	Ground	Koala	Native	Koala	1			
Winter	12	Ground	Cat	Introduced	Feral predator	1			
Winter	12	Ground	Wild dog	Undefined	Feral predator	1			
Winter	12	Ground	Long-nosed bandicoot	Native	Bandicoot	1	1		

Table B2: Sand pad data recorded over 8 nights in spring/summer (ss) and winter (w) during year four of operational phase monitoring WC2NH, 2022. [I] = Introduced, + = probable records.

Species/group	1		2		3		4		5/6		7		8		9/10		11/12	
	SS	W	SS	W	SS	W	SS	W	SS	W	SS	W	SS	W	SS	W	SS	W
Short-beaked echidna				*														
Antechinus spp.									*	*		*	*	*		*	*	*
Peramelidae spp. (bandicoot)	*	*	*	*		*	*	*		*	*	*	*	*	*	*		*
Trichosurus spp.		*				*	*		*	*						*	*	
Red-necked wallaby						*												
Swamp wallaby		*	*	*			*	*			*	*	*	*	*			
Wallaby spp.	*				*	*												
House mouse										*						*		*
Water rat										*				*				
Rodent spp.			*				*	*	*	*	*				*	*	*	*
Dog																		
Red fox [I]	*	*	*	*	*	*		*								*	*	*
Cat [I]			*		*	*	*		*				*	*				
Lace monitor					*		*		*				*					
Skink																		*
Medium reptile																	*	
Medium frog spp.					+												+	
Bird spp.										*								
Total no. Species/groups	3	4	5	4	5	6	6	4	5	7	3	3	5	5	3	6	6	6

Table B3: Scat and track data recorded during camera monitoring during winter (w) and summer (ss) year four operational phase monitoring WC2NH, 2022.

Species/group	1		2		3		4		5/6		7		8		9/10		11/12	
	SS	W	SS	W	SS	W	SS	W	SS	W	SS	W	SS	W	SS	W	SS	W
Short-beaked echidna				*		*									*			
Antechinus spp.	*			*	*			*	*				*	*		*		*
Peramelidae spp. (bandicoot)		*	*				*	*				*	*	*	*	*	*	*
Trichosurus spp.							*		*			*		*	*	*		
Swamp wallaby							*	*		*		*				*		
Wallaby spp.	*	*	*	*	*		*	*			*	*	*				*	*
Rodent spp.				*				*	*	*		*		*	*	*		*
Dog		*																
Red fox [I]	*	*		*				*				*			*		*	*
Cat [I]			*	*	*	*					*		*			*		*
Lace monitor					*		*				*		*		*	*		
Eastern water dragon									*									
Small/medium reptile spp.	*			*		*			*							*		
Medium lizard spp.		*	*													*		*
Total no. Species/groups		5	4	7	4	3	5	6	5	2	3	6	5	4	6	9	3	7

Table B4: Tile inspection data recorded during year four operational phase monitoring WC2NH, 2022.

Site	No. Tiles	Check no.	Date	Fauna present	Comments
2	1	1	15/11/21	Nil	1 tile destroyed
		2	16/11/21	Nil	
		3	17/11/21	Nil	
		4	18/11/21	Nil	
		5	19/11/21	Nil	
		6	20/11/21	Nil	
		7	22/12/21	Nil	
		8	2/2/22	nil	
3	1	1	15/11/21	Nil	1 tile destroyed/missing
		2	16/11/21	Nil	
		3	17/11/21	Nil	
		4	18/11/21	Nil	
		5	19/11/21	Nil	
		6	20/11/21	Nil	
		7	22/12/21	Nil	
		8	2/2/22	nil	
4	2	1	15/11/21	Nil	
		2	16/11/21	Nil	
		3	17/11/21	Nil	
		4	18/11/21	Nil	
		5	19/11/21	Nil	
		6	20/11/21	Nil	
		7	22/12/21	Nil	
		8	2/2/22	nil	
5N	1	1	15/11/21	Nil	
		2	16/11/21	Nil	
		3	17/11/21	Nil	
		4	18/11/21	Nil	
		5	19/11/21	Nil	
		6	20/11/21	Nil	
		7	22/12/21	Nil	
		8	2/2/22	nil	
5S		1		No check	Missing
		2		No check	
		3		No check	
		4		No check	
		5		No check	
		6		No check	
		7		No check	

Site	No. Tiles	Check no.	Date	Fauna present	Comments
		8		No check	
6	2	1	15/11/21	Nil	
		2	16/11/21	Nil	
		3	17/11/21	Nil	
		4	18/11/21	Nil	
		5	19/11/21	Nil	
		6	20/11/21	Nil	
		7	22/12/21	Nil	
		8	2/2/22	nil	
7	2	1	15/11/21	Nil	
		2	16/11/21	Nil	
		3	17/11/21	Nil	
		4	18/11/21	Nil	
		5	19/11/21	Nil	
		6	20/11/21	Nil	
		7	22/12/21	Nil	
		8	2/2/22	nil	
8	2	1	15/11/21	Nil	
		2	16/11/21	Nil	
		3	17/11/21	Nil	
		4	18/11/21	Nil	
		5	19/11/21	Nil	
		6	20/11/21	Nil	
		7	22/12/21	Nil	
		8	2/2/22	nil	
9 East	2	1	15/11/21	Nil	
		2	16/11/21	Nil	
		3	17/11/21	Nil	
		4	18/11/21	Nil	
		5	19/11/21	Nil	
		6	20/11/21	Nil	
		7	22/12/21	Nil	
		8	2/2/22	nil	
10 West	2	1	15/11/21	Nil	
		2	16/11/21	Nil	
		3	17/11/21	Nil	
		4	18/11/21	Nil	
		5	19/11/21	Nil	
		6	20/11/21	Nil	
		7	22/12/21	Nil	
		8	2/2/22	nil	

Site	No. Tiles	Check no.	Date	Fauna present	Comments
11 East	2	1	15/11/21	Nil	
		2	16/11/21	Nil	
		3	17/11/21	Nil	
		4	18/11/21	Nil	
		5	19/11/21	Nil	
		6	20/11/21	Nil	
		7	22/12/21	Nil	
		8	2/2/22	nil	
12 West	2	1	15/11/21	Nil	
		2	16/11/21	Nil	
		3	17/11/21	Nil	
		4	18/11/21	Nil	
		5	19/11/21	Nil	
		6	20/11/21	Nil	
		7	22/12/21	Nil	
		8	2/2/22	Nil	

Table B5: Daytime searches of adjacent habitat data during winter year four WC2NH monitoring, 2022. Msb = moves small branches, Mlb = moves large branches and RL = rustles leaves.

Location	Side	Date	Obs. No.	Observers	Start	Finish	Species	Wind	Cloud	Rain	Air Temp	Humidity	Comment
11&12	E	24/8/22	1	AE EL	2:45	3:00	bandicoot diggings wallaby poo and lampropholis spp.	MSB	0/8	Nil	15.5	53	Nil
	W	24/8/22	1	LA/FM	1445	1500	4 x lampropholis delicata	MSB	0/8	Nil	15.5	53	Nil
	E	29/8/22	2	LA/AE/EL	955	1005	Bandicoot and antechinus spp, short-eared brushtail possum scat	RL	8/8	Nil	16.8	86	Nil
	W	29/8/22	2	LA/AE/EL	1007	1017	Lampropholis wallaby scat	RL	8/8	Nil	16.8	86	Nil
9&10	E	24/8/22	1	LA/FM	1517	1532	Bandicoot diggings, wallaby scat, fox den??	MSB	0/8	Nil	15.5	53	Nil
	W	24/8/22	1	AL EL	3:15	3:30	Swamp wallaby scat striped mash frog bandicoot digs	MSB	0/8	Nil	15.5	53	Nil
	E	30/8/22	2	EL/LA	1505	1520	*Calyptotis ruficauda* 2x lampropholis, wallaby scat	Nil	8/8	Nil	19.3	93	Nil
	W	30/8/22	2	EL/LA	1521	1536	Bandicoot diggings, Crinia signifera	Nil	8/8	Nil	19.3	93	Nil
8	E	24/08/2022	1	FM/LA	1536	1601	Crinia signifera, antechinus scat, swamp wallaby scat	MSB	0/8	Nil	15.5	53	Nil
	W	24/08/2022	1	EL/AE	1536	1601	Wallaby scat	MSB	0/8	Nil	15.5	53	Nil
	E	30/8/22	2	EL/LA	1415	1431	Bandicoot, wallaby spp.	Nil	8/8	Very light	19.3	93	Nil
	W	30/8/22	2	EL/LA	1432	1447	Bandicoot, wallaby spp.	Nil	8/8	Very light	19.3	94	Nil
7	E	30/8/22	1	EL/LA	1517	1532	Bandicoot swamp wallaby	RL	8/8	Nil	16.8	48	Nil
	W	30/8/22	1	EL/LA	1533	1549	Nil	RL	8/8	Nil	16.8	48	Nil
	E	29/8/22	2	LA/AE/EL	1355	1407	EG scat, wallaby, bandicoot scat	ML	8/8	Nil	16.8	48	Nil
	W	31/8/2022	2	AE/EL	1205	1220	No new records	MSB	4/8	Nil	19.8	84	Nil
5&6	E	24/8/222	1	EL/FM	1315	1330	Bandicoot diggings wallaby scat	ML	0/8	Nil	16.8	48	Nil
	W	24/8/222	1	LA/FM	1332	1347	Lace monitor, bandicoot diggings	ML	0/8	Nil	16.8	48	Nil
	E	29/8/22	2	AE LA. EL	1331	1341	Lace monitor, bandicoot	RL	8/8	Nil	16.8	86	
	W	30/8/22	2	EL/LA	1548	1603	Swamy wallaby tracks b diggings	Nil	8/8	Very light	19.3	94	Nil
4	E	24/8/22	1	Ae and EL	205	0.0972	wallaby track and scat fox track and bandicoot digs	MSB	0/8	Nil	15.5	53	Nil
	W	24/8/22	1	Ae and EL	0.07639	0.0868	wallaby scat bandicoot digs	MSB	0/8	Nil	15.5	53	Nil
	E	29/8/22	2	LA/AE	845	900	Bandicoot spp.	Nil	0/8	Nil	14.8	84	Nil
	W	29/8/22	2	LA/AE	8:25	840	Bandicoot, wallaby scat, koala scat	Nil	0/8	Nil	14.8	84	Nil
3	E	30/8/22	1	LA/EL	1515	1530	Bandicoot spp., cat	ML	8/8	Nil	16.8	48	Nil
	W	30/8/22	1	LA/EL	1455	1510	Bandicoot spp., dog, swamp wallaby (tracks)	ML	8/8	Nil	16.8	48	Nil
	E	29/8/22	1	LA/EL/AE	1322	1332	Fox scat, bandicoot diggings, wallaby scat	RL	8/8	Nil	16.8	86	Nil
	W	29/8/22	2	AE/EL	13:05	1320	Crinia signifera	MSB	4/8	Nil	17.9	84	Nil
2	E	30/8/22	1	LA/EL	1408	1422	Bandicoot spp.	ML		Nil	16.8	48	Nil
	W	30/8/22	1	LA/EL	1431	1446	Bandicoot spp.	ML	8/8	Nil	16.8	48	Nil
	E	31/8/22	2	AE LA. EL	12:30	12:40	Red belly black snake, fox scat, gutchonoities, >10 delicata, wallaby scat	MSB	4/8	Nil	19.8	0:00	Nil
	W	31/8/22	2	AE LA. EL	12:45	12:55	*Calyptotis ruficauda* 6x lampropholis delicata wallaby scat and wallaby bandicoot digs litoria fallax calling	MSB	4/8	Nil	19.8	0:00	Nil
1	E	24/8/22	1	Ae and EL	1:00	1:15	bandicoot diggings and lampropholis spp.	Nil	0/8	Nil	Nil	Nil	Nil
	E	29/8/22	1	Ae and EL	1:15	1:30	bandicoot diggings and dog scat	RL	8/8	Nil	16.8	86	Nil
	W	29/08/22	2	AE LA. EL	11:20	11:30	Btp scat	Nil	0/8	Nil	17.9	84	Nil
	W	29/08/22	2	AE LA. EL	11:30	11:40	Eastern water dragon, bandicoot digs wallaby scat lampropholis delicata x3 litoria fallax	Nil	0/8	Nil	17.9	84	Nil

Table B6: Nocturnal spotlight surveys of adjacent habitat during winter year four WC2NH monitoring, 2022. GHFF = grey-headed flying fox, SuG = sugar glider, Lit = Litoria species, A. brevis = Adelotus brevis, ONJ = Owlet-Nightjar.

Location	Side	Date	Obs. No.	Observers	Start Time	Finish Time	Species	Wind	Rain	Visibility	Air Temp	Humidity	Comment
11&12	E	23/7/22	1	LA/DW	2216	2246	Nil	Nil	Nil	Good	14.5	86	Nil
	W	22/7/22	1	LA/DW	2216	2246	Wallaby spp.	Nil	Nil	Good	14.5	86	Nil
	E	25/7/22	2	LA/DW	1911	1926	Nil	Nil	Nil	Good	12.7	87	Nil
	W	25/7/22	2	LA/DW	1926	1941	FF spp.	Nil	Nil	Good	12.7	87	Nil
9&10	E	23/7/22	1	LA/DW	2144	2214	Nil	Nil	Nil	Good	14.5	86	Nil
	W	22/7/22	1	LA/DW	2144	2214	Nil	Nil	Nil	Good	14.5	86	Nil
	E	25/7/22	2	LA/DW	2026	2056	Nil	Nil	Nil	Good	12.7	87	Nil
	W	25/7/22	2	LA/DW	2026	2056	Rattus spp.	Nil	Nil	Good	12.7	87	Nil
8	E	23/7/22	1	LA/DW	2107	2137	Nil	Nil	Nil	Good	14.5	86	Nil
	W	22/7/22	1	LA/DW	2107	2137	Nil	Nil	Nil	Good	14.5	86	Nil
	E	25/7/22	2	LA/DW	1950	2020	Melomys spp.	Nil	Nil	Good	12.7	87	Nil
	W	25/7/22	2	LA/DW	1950	2020	RTP, Rattus spp.	Nil	Nil	Good	12.7	87	Nil
7	E	23/7/22	1	LA/DW	2031	2101	Swamp wallaby	Nil	Nil	Good	14.5	86	Nil
	W	22/7/22	1	LA/DW	2031	2101	Nil	Nil	Nil	Good	14.5	86	Nil
	E	25/7/22	2	LA/DW	2145	2215	C. Signifera, swamp wallaby	Nil	Nil	Good	12.7	87	Nil
	W	25/7/22	2	LA/DW	2145	2215	Nil	Nil	Nil	Good	12.7	87	Nil
5&6	E	23/7/22	1	LA/DW	1955	2025	C. Signifera, swamp wallaby	Nil	Nil	Good	14.5	86	Nil
	W	22/7/22	1	LA/DW	1955	2025	C. Signifera	Nil	Nil	Good	14.5	86	Nil
	E	25/7/22	2	LA/DW	2103	2133	Nil	Nil	Nil	Good	12.7	87	Nil
	W	25/7/22	2	LA/DW	2103	2133	C. Signifera, long-nosed bandicoots	Nil	Nil	Good	12.7	87	Nil
4	E	23/7/22	1	LA/DW	1912	1942	Melomys spp.	Nil	Nil	Good	14.5	86	Nil
	W	22/7/22	1	LA/DW	1912	1942	Nil	Nil	Nil	Good	14.5	86	Nil
	E	25/7/22	2	LA/DW	1830	1900	Melomys spp.	Nil	Nil	Good	12.7	87	Nil
	W	25/7/22	2	LA/DW	1830	1900	Nil	Nil	Nil	Good	12.7	87	Nil
3 (E only)	E	23/7/22	1	LA/DW	1907	1913	Nil	Nil	Nil	Good	14.5	86	Nil
	E	23/7/22	2	LA/DW	2135	2140	Nil	Nil	Nil	Nil	Nil	Nil	Nil
2	E	23/7/22	1	LA/DW	1836	1906	C. Signifera, GHFF	Nil	Nil	Good	14.5	86	Nil
	W	22/7/22	1	LA/DW	1836	1906	black flying fox	Nil	Nil	Good	14.5	86	Nil
	E	25/7/22	2	LA/DW	2222	2252	Sug	Nil	Nil	Good	12.7	87	Nil
	W	25/7/22	2	LA/DW	2222	2252	Lit fallax	Nil	Nil	Good	12.7	87	Nil
1	E	23/7/22	1	LA/DW	1730	1800	Nil	Nil	Nil	Good	14.5	86	Nil
	W	22/7/22	1	LA/DW	1730	1800	Swamp wallaby	Nil	Nil	Good	14.5	86	Nil
	E	25/7/22	2	LA/DW	1743	1813	Nil	Nil	Nil	Good	12.7	87	Nil
	W	25/7/22	2	LA/DW	1743	1813	Nil	Nil	Nil	Good	12.7	87	Nil

Table B7: Fauna captured during adjacent habitat trapping surveys during year four operational monitoring WC2NH, 2021-2022. Uk = unknown. NR= no record

Season	Site	Side	Date	Trap type	Species	No. individuals	Sex	Weight	Comments
Winter	1	East	27/08/2022	Ground elliot	Black rat		M		Brushtail raided traps both side
Winter	1	East	28/08/2022	Cage trap	Black rat		NR	NR	
Winter	1	West	28/08/2022	Ground elliot	Black rat				Euthanised
Winter	1	West	28/08/2022	Ground elliot	Black rat				Euthanised
Winter	1	East	29/08/2022	Ground elliot	Black rat		Female		
Winter	1	East	29/08/2022	Ground elliot	Black rat		Female	Uk	
Winter	1	West	29/08/2022	Ground elliot	Black rat		Male		
Winter	1	East	29/08/2022	Arboreal elliot	Brown antechinus		Male	Uk	
Winter	1	East	29/08/2022	Ground elliot	Brown antechinus		Female	Uk	
Winter	1	West	28/08/2022	Cage trap	Northern brown bandicoot		NR	NR	
Winter	1	West	29/08/2022	Cage trap	Northern brown bandicoot		Uk	Uk	
Winter	2	West	25/08/2022	Pitfall	Adelotus brevis		Unk		
Winter	2	East	24/08/2022	Arboreal elliot	Black rat		Male		
Winter	2	East	26/08/2022	Arboreal elliot	Black rat		Male		
Winter	2	East	26/08/2022	Ground elliot	Black rat		Unk	Unk	
Winter	2	East	24/08/2022	Ground elliot	Brown antechinus		Female		
Winter	2	West	24/08/2022	Ground elliot	Brown antechinus		Female		
Winter	2	East	25/08/2022	Ground elliot	Brown antechinus		Male	65	
Winter	2	East	24/08/2022	Ground elliot	Brown antechinus		Female		
Winter	2	East	26/08/2022	Ground elliot	Bush rat		Female	109	Stumpy tail
Winter	2	East	26/08/2022	Ground elliot	Bush rat		Female	136	
Winter	2	East	26/08/2022	Ground elliot	Bush rat		Male	79	
Winter	2	East	26/08/2022	Arboreal elliot	Fawn-footed melomys		Female	Nil	
Winter	2	West	26/08/2022	Ground elliot	Fawn-footed melomys		F	90	
Winter	3	West	25/08/2022	Ground elliot	Black rat		Immature		
Winter	3	East	25/08/2022	Ground elliot	Brown antechinus		Female	55	
Winter	3	West	25/08/2022	Ground elliot	Long-nosed bandicoot		Female	300+	Too big for scale
Winter	3	East	26/08/2022	Cage trap	Northern brown bandicoot		uk	uk	
Winter	4	West	27/08/2022	Ground elliot	Brown antechinus				
Winter	4	West	27/08/2022	Cage trap	Bush rat		M	??	Escape
Winter	4	West	27/08/2022	Ground elliot	Bush rat		M	144	
Winter	4	West	28/08/2022	Ground elliot	Bush rat		F	136	
Winter	4	West	28/08/2022	Ground elliot	Bush rat		Male	155	
Winter	4	West	29/08/2022	Ground elliot	Bush rat		Female	111	
Winter	4	West	29/08/2022	Ground elliot	Bush rat		Male	123	
Winter	4	East	29/08/2022	Ground elliot	Bush rat		Female	164	
Winter	4	East	27/08/2022	Arboreal elliot	Fawn-footed melomys		F	62	
Winter	4	East	27/08/2022	Arboreal elliot	Fawn-footed melomys		M	81	
Winter	4	West	27/08/2022	Ground elliot	Fawn-footed melomys		M	71	
Winter	4	West	27/08/2022	Ground elliot	Fawn-footed melomys		F	58	
Winter	4	East	28/08/2022	Arboreal elliot	Fawn-footed melomys		F	68	
Winter	4	East	28/08/2022	Arboreal elliot	Fawn-footed melomys		M	74	

Season	Site	Side	Date	Trap type	Species	No. individuals	Sex	Weight	Comments
Winter	4	West	28/08/2022	Ground elliot	Fawn-footed melomys		F	59	
Winter	4	West	29/08/2022	Arboreal elliot	Fawn-footed melomys		Male	83	
Winter	4	West	29/08/2022	Arboreal elliot	Fawn-footed melomys		Male	86	
Winter	4	East	29/08/2022	Arboreal elliot	Fawn-footed melomys		Male	100	
Winter	7	West	26/08/2022	Ground elliot	Black rat		Male	180	
Winter	7	East	24/08/2022	Ground elliot	Brown antechinus		Unknown	30	
Winter	7	East	24/08/2022	Ground elliot	Brown antechinus		Female	26	
Winter	7	East	25/08/2022	Ground elliot	Brown antechinus		Male	38	
Winter	7	East	25/08/2022	Ground elliot	Brown antechinus		Male	44	
Winter	7	East	26/08/2022	Ground elliot	Brown antechinus		m	38	deceased
Winter	7	East	24/08/2022	Ground elliot	Bush rat		Male	138	
Winter	7	West	24/08/2022	Ground elliot	Bush rat		Female	165	
Winter	7	West	24/08/2022	Ground elliot	Bush rat		Female	128	
Winter	7	West	24/08/2022	Ground elliot	Bush rat		Female	80	Immature
Winter	7	West	24/08/2022	Ground elliot	Bush rat		Male	154	
Winter	7	West	26/08/2022	Cage trap	Bush rat		Na	Na	
Winter	7	West	26/08/2022	Ground elliot	Bush rat		Male	166	
Winter	8	West	25/08/2022	Ground elliot	Black rat				
Winter	8	West	25/08/2022	Ground elliot	Black rat				
Winter	8	West	26/08/2022	Ground elliot	Black rat		m	201	
Winter	8	West	24/08/2022	Ground elliot	Brown antechinus		M	43	
Winter	8	West	24/08/2022	Ground elliot	Brown antechinus		M	39	
Winter	8	West	24/08/2022	Ground elliot	Brown antechinus		M	51	
Winter	8	West	24/08/2022	Ground elliot	Brown antechinus		M	40	
Winter	8	East	24/08/2022	Ground elliot	Brown antechinus		F	26	
Winter	8	West	25/08/2022	Ground elliot	Brown antechinus		Female		
Winter	8	West	25/08/2022	Ground elliot	Brown antechinus		Male	42	deceased
Winter	8	East	25/08/2022	Ground elliot	Brown antechinus		Male	29	
Winter	8	East	25/08/2022	Ground elliot	Brown antechinus		Male	47	
Winter	8	East	25/08/2022	Ground elliot	Brown antechinus		Male		Deceased
Winter	8	West	26/08/2022	Ground elliot	Brown antechinus		m	20	
Winter	8	West	26/08/2022	Ground elliot	Brown antechinus		Female	39	
Winter	8	East	26/08/2022	Ground elliot	Brown antechinus		Female	39	
Winter	8	East	24/08/2022	Ground elliot	Bush rat		M	172	
Winter	8	East	26/08/2022	Ground elliot	Bush rat		Male	175	
Winter	8	West	24/08/2022	Ground elliot	Fawn-footed melomys		F	64	
Winter	8	East	25/08/2022	Ground elliot	Fawn-footed melomys		Male	85	
Winter	8	West	26/08/2022	Ground elliot	Fawn-footed melomys		m	84	
Winter	8	West	24/08/2022	Cage trap	Northern brown bandicoot		F	ND	
Winter	5/6	West	25/08/2022	Cage trap	Black rat		Uk	Uk	
Winter	5/6	West	26/08/2022	Ground elliot	Brown antechinus		m	45	Deceased
Winter	5/6	West	26/08/2022	Ground elliot	Brown antechinus		m	60	
Winter	5/6	West	24/08/2022	Ground elliot	Bush rat		Male	150	
Winter	5/6	West	25/08/2022	Ground elliot	Bush rat		Male	155	
Winter	5/6	West	25/08/2022	Ground elliot	Bush rat		Female	110	

Season	Site	Side	Date	Trap type	Species	No. individuals	Sex	Weight	Comments
Winter	5/6	West	25/08/2022	Ground elliot	Bush rat		Male	175	
Winter	5/6	West	26/08/2022	Ground elliot	Bush rat		m		
Winter	5/6	East	24/08/2022	Arboreal elliot	Fawn-footed melomys		Female	72	
Winter	5/6	East	24/08/2022	Ground elliot	Fawn-footed melomys		Male	82	
Winter	5/6	East	24/08/2022	Ground elliot	Fawn-footed melomys		Female	75	
Winter	5/6	West	24/08/2022	Ground elliot	Fawn-footed melomys		Male	34	
Winter	5/6	East	25/08/2022	Arboreal elliot	Fawn-footed melomys		Male	70	
Winter	5/6	West	26/08/2022	Ground elliot	Fawn-footed melomys		m	119	
Winter	5/6	East	24/08/2022	Pitfall	Pseudophryne coriacea		Unk		
Winter	9/10	West	25/08/2022	Ground elliot	Black rat		??	??	
Winter	9/10	West	25/08/2022	Arboreal elliot	Brown antechinus		male	42	
Winter	9/10	West	25/08/2022	Arboreal elliot	Brown antechinus		male	39	
Winter	9/10	West	25/08/2022	Ground elliot	Brown antechinus		Female	38	
Winter	9/10	East	25/08/2022	Ground elliot	Brown antechinus		Male	39	
Winter	9/10	East	25/08/2022	Ground elliot	Brown antechinus		Male	40	
Winter	9/10	East	25/08/2022	Ground elliot	Brown antechinus		Male	37	
Winter	9/10	West	25/08/2022	Ground elliot	Brown antechinus		Male	35	
Winter	9/10	West	26/08/2022	Ground elliot	Brown antechinus		Male	45	
Winter	9/10	West	26/08/2022	Ground elliot	Brown antechinus		Male	52	
Winter	9/10	East	24/08/2022	Ground elliot	Bush rat		M	175	
Winter	9/10	East	25/08/2022	Ground elliot	Bush rat		Female	105	
Winter	9/10	West	26/08/2022	Ground elliot	Bush rat		Male	140	
Winter	9/10	East	24/08/2022	Ground elliot	Fawn-footed melomys		M	75	
Winter	9/10	West	24/08/2022	Ground elliot	Fawn-footed melomys		M	80	
Winter	9/10	West	25/08/2022	Ground elliot	Fawn-footed melomys		Male	68	
Winter	9/10	West	26/08/2022	Ground elliot	Fawn-footed melomys		m	71	
Winter	9/10	West	26/08/2022	Ground elliot	Fawn-footed melomys		f	73	
Winter	9/10	West	26/08/2022	Ground elliot	Fawn-footed melomys		F	65	
Winter	11/12	East	24/08/2022	Cage trap	Black rat		UK		
Winter	11/12	East	26/08/2022	Cage trap	Black rat		uk	uk	
Winter	11/12	East	24/08/2022	Pitfall	Brown antechinus		M	9	Juvenile
Winter	11/12	East	26/08/2022	Ground elliot	Brown antechinus		m	49	
Winter	11/12	East	26/08/2022	Ground elliot	Brown antechinus		Male	125	
Winter	11/12	East	25/08/2022	Ground elliot	Bush rat		Female	69	Probably carrying young
Winter	11/12	East	26/08/2022	Ground elliot	Bush rat		f	4	
Winter	11/12	East	26/08/2022	Ground elliot	Bush rat		Female	130	
Winter	11/12	West	24/08/2022	Ground elliot	Fawn-footed melomys		M	82	
Winter	11/12	East	26/08/2022	Ground elliot	Fawn-footed melomys		Female	72	
Winter	11/12	East	26/08/2022	Ground elliot	House mouse		Uk	21	
Winter	11/12	East	26/08/2022	Pitfall	Lampropholis delicata		Uk	UK	
Winter	11/12	East	24/08/2022	Arboreal elliot	Sugar glider		F	119	
Winter	11/12	West	25/08/2022	Arboreal elliot	Sugar glider		Male	130	
Winter	11/12	East	26/08/2022	Arboreal elliot	Sugar glider		f	168	
spring/summer	1	E	17/11/21	Cage trap	Black rat	2	Uk	Uk	
spring/summer	1	w	18/11	cage trap	Black rat		F	uk	euthanised

Season	Site	Side	Date	Trap type	Species	No. individuals	Sex	Weight	Comments
spring/summer	1	e	19/11	cage trap	Black rat		f		
spring/summer	1	E	18/11	arboreal	Brown antechinus		F	27	
spring/summer	1	e	19/11	ground	Brown antechinus		f	23	
spring/summer	1	e	19/11	aboreal	Brown antechinus		f	25	
spring/summer	1	w	19/11/21	pitfall	Calyptotis ruficauda				
spring/summer	1	E	18/11	pitfall	Lampropholis delicata				
spring/summer	1	W	17/11/21	cage trap	short-eared brushtail possum				
spring/summer	1	w	19/11/21	cage trap	short-eared brushtail possum		f		
spring/summer	2	E	17/11/21	Arboreal	Brown antechinus		F	26	
spring/summer	2	E	17/11/21	Ground Elliot	Brown antechinus		F	26	
spring/summer	2	E	18/11	Aboreal	Brown antechinus		F	32	
spring/summer	2	E	18/11	Aboreal	Brown antechinus		uk	-	
spring/summer	2	E	19/11	ground	Brown antechinus		F	21	
spring/summer	2	E	19/11	arboreal	Brown antechinus		F	28	
spring/summer	2	W	17/11/21	Ground Elliot	Brown antechinus		F	29	
spring/summer	2	W	18/11	ground elliot	Brown antechinus		F	24	
spring/summer	2	w	19/11	ground	Brown antechinus		f	30	
spring/summer	2	W	17/11/21	Ground Elliot	Bush rat		F	125	
spring/summer	2	W	19/11	Cage	Common brushtail possum		Uk	Uk	
spring/summer	3	e	19/11	black rat	Black rat		f		
spring/summer	3	w	19/11/21	pitfall	Calyptotis ruficauda				
spring/summer	3	W	18/11	pitfall	Lampropholis delicata				
spring/summer	3	w	19/11/21	pitafall	lampropholis delicata				
spring/summer	4	E	17/11/21	Arboreal	Brown antechinus		F		
spring/summer	4	E	18/11	ground	Brown antechinus		uk		
spring/summer	4	W	17/11	Ground elliott	Bush rat		M	140OBJ	
spring/summer	4	w	18/11	ground elliot	Bush rat		f	118	
spring/summer	4	E	17/11/21	Arboreal	Fawn-footed melomys		F	70	
spring/summer	4	W	17/11/21	Ground elliot	Fawn-footed melomys				
spring/summer	4	e	19/11	aboreal	Fawn-footed melomys		f		
spring/summer	7	W	17/11	ground Elliott	Brown antechinus		f	29	
spring/summer	7	E	19/11/2021	ground Elliott	Bush rat		M		
spring/summer	7	w	17/11	ground Elliott	Bush rat		f	96	
spring/summer	7	W	18/11	Ground elliott	Bush rat		F	140	
spring/summer	7	W	19/11	Ground elliott	Bush rat		M	148	
spring/summer	7	W	19/11	Ground elliott	Bush rat		F	130	
spring/summer	7	E	17/11	cage trap	Lace monitor				
spring/summer	8	E	18/11	Ground elliott	Brown antechinus		F		
spring/summer	8	W	17/11	Ground elliott	Bush rat		F	105	
spring/summer	8	W	19/11/21	Ground elliott	Bush rat				
spring/summer	8	E	19/11	Arboreal	Fawn-footed melomys		F	75	
spring/summer	8	E	18/11	Cage	Lace monitor				
spring/summer	8	W	18/11	Cage	Lace monitor				
spring/summer	8	W	19/11/21	Cage	Lace monitor				
spring/summer	8	E	19/11	Cage	Northern brown bandicoot				

Season	Site	Side	Date	Trap type	Species	No. individuals	Sex	Weight	Comments
spring/summer	8	W	19/11/21	pitfall	Pseudophryne coriacea				Deceased
spring/summer	9/10	E	19/11/21	Ground elliott	Fawn-footed melomys		F		
spring/summer	9/10	E	17/11	pitfall	Lampropholis delicata				
spring/summer	9/10	E	18/11/21	Pitfall	Lampropholis delicata	2			
spring/summer	11/12	W	19/11/21	Pitfall	Brown antechinus				
spring/summer	11/12	e	17/11/2021	ground Elliott	Fawn-footed melomys		F	90	
spring/summer	11/12	E	17/11/21	pitfall	Lampropholis delicata				
spring/summer	11/12	E	18/11/21	Pitfall	Lampropholis delicata				
spring/summer	11/12	w	17/11/2021	pit fall	Lampropholis delicata				
spring/summer	11/12	W	18/11/21	Pitfall	Lampropholis delicata				
spring/summer	11/12	W	19/11/21	Pitfall	Lampropholis delicata				
spring/summer	11/12	E	18/11/21	Arboreal	Sugar glider		Pr F		
spring/summer	11/12	W	19/11/21	arboreal	Sugar glider		F		
spring/summer	5&6	W	18/11	Pitfall	Brown antechinus				
spring/summer	5&6	W	17/11	ground	Bush rat		f	135	
spring/summer	5&6	W	18/11	Ground elliott	Bush rat		M	145	
spring/summer	5&6	w	19/11/21	Ground elliott	Bush rat		F		
spring/summer	5&6	w	19/11/21	Ground elliott	Bush rat		M		
spring/summer	5&6	E	17/11	arboreal	Fawn-footed melomys		m		
spring/summer	5&6	E	17/11	arboreal	Fawn-footed melomys		m		
spring/summer	5&6	E	18/11	Ground elliott	Fawn-footed melomys		M		
spring/summer	5&6	E	19/11	Arboreal	Fawn-footed melomys		F	80	
spring/summer	5&6	E	19/11	Ground elliott	Fawn-footed melomys		M	72	
spring/summer	5&6	W	17/11	cage	short-eared brushtail possum				
spring/summer	5&6	W	18/11	Cage	short-eared brushtail possum				

Table B8: Fauna recorded in hair funnel surveys during year four operational monitoring WC2NH, 2022.

Site	Position	Date	Species	Species	Species
1	East 1	31/8/22	Trichosurus vulpecula	Human	
1	East 2	31/8/22	No hair		
1	West 2	31/8/22	Isoodon macrourus		
1	West 1	31/8/22	Isoodon macrourus		
2	East 1	31/8/22	Isoodon macrourus	Antechinus stuartii	
2	West 2	31/8/22	Isoodon macrourus	Rattus fuscipes	
2	West 1	31/8/22	Rattus fuscipes		
2	East 2	31/8/22	Antechinus stuartii		
3	West 2	31/8/22	Wallabia bicolor		
3	West 1	31/8/22	Rattus sp.		
3	East 2	31/8/22	No hair		
3	East 1	31/8/22	Isoodon macrourus		

4	East 1	31/8/22	Rattus fuscipes		
4	East 2	31/8/22	Rattus fuscipes		
4	West 1	31/8/22	Antechinus stuartii		
4	West 2	31/8/22	Antechinus sp.		
6-5	West 1	31/8/22	Isoodon macrourus	Rattus fuscipes	Antechinus stuartii
6-5	West 2	31/8/22	Antechinus stuartii		
6-5	East 1	31/8/22	Rattus fuscipes		
6-5	East 2	31/8/22	Rattus fuscipes	Antechinus stuartii	
7	East 1	31/8/22	Rattus fuscipes		
7	East 2	31/8/22	Rattus fuscipes	Antechinus stuartii	
7	West 1	31/8/22	Rattus fuscipes		
7	West 2	31/8/22	Isoodon macrourus	Rattus fuscipes	
8	West 1	31/8/22	Rattus fuscipes	Antechinus stuartii	
8	East 1	31/8/22	Rattus fuscipes		
8	East 2	31/8/22	Rattus fuscipes		
8	West 2	31/8/22	Isoodon macrourus	Antechinus stuartii	
9-10	West 2	31/8/22	Isoodon macrourus	Antechinus stuartii	
9-10	West 1	31/8/22	Isoodon macrourus	Rattus fuscipes	
9-10	East 2	31/8/22	Antechinus sp.		
9-10	East 1	31/8/22	Antechinus stuartii		
11-12	West 2	31/8/22	Antechinus stuartii	Rattus sp.	
11-12	West 2	31/8/22	Rattus fuscipes		
11-12	West 1	31/8/22	Antechinus stuartii		
11-12	East 2	31/8/22	Rattus fuscipes	Antechinus stuartii	