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Department of **Biodiversity, Conservation and Attractions**

Northern Quoll targeted surveys at Wall Creek and Mesa 228

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Northern Quoll targeted surveys at Wall Creek and Mesa 228

Report prepared for Roy Hill Pty Ltd by
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December 2017

GOVERNMENT OF WESTERN AUSTRALIA

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Contents

Appendices

Figures

Tables

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Summary

Roy Hill Pty Ltd seek to better understand the population dynamics of northern quoll in the vicinity of their Roy Hill to Port Hedland iron ore railway and are required to meet condition 3 of their *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC) approval 2011/5867 to offset impacts on the endangered northern quoll. For this purpose, two monitoring sites were added to the Department of Biodiversity, Conservation and Attractions northern quoll Regional Monitoring Program in 2015. The sites, Mesa 228 (including the nearby small rocky outcrop habitat named 'Quoll Knoll'), and Wall Creek, are both in the eastern Chichester Ranges. These sites were surveyed in 2017 using trapping, camera traps and scat searches.

Northern quolls were intermittently present at Wall Creek, following a single detection in 2016. At least three individuals used Wall Creek during April, May and August 2017. No introduced predators were detected at Wall Creek during four months of camera trap survey.

There was no evidence of quolls using Mesa 228, despite its close proximity to the Quoll Knoll population. Feral cats, dingoes and foxes were detected at this location during the year, as well as 21 other identifiable species. This represents the first inland records of red foxes in quoll habitats since the inception of the Northern Quoll Regional Monitoring Project.

Permanent camera trap stations at Quoll Knoll indicate a recolonization by northern quolls of the area in April 2017, after a 9-month absence, with at least four individuals using the complex and one individual having a continued presence on camera. During this time there was only one detection of a feral cat recorded on the permanent camera traps in 2017.

Recommended actions include:

- Maintain passive camera trap presence at Quoll Knoll complex with at least 4 cameras and West Shaw River Rail bridge (RHQMP05A) quoll latrine site. Periodically review images for northern quoll records and cat records.
- Continue feral cat/fox control via trapping at Quoll Knoll and rail corridor area in order to keep introduced predator numbers low. Leghold traps are not recommended near Quoll Knoll due to the likelihood of lethal damage to a quoll should it be caught.
- Trial of Felixer feral cat grooming trap for cat control, subject to APVMA and other approvals.
- Continue to monitor Wall Creek via camera traps for monitoring quoll and introduced predator densities for a 4-6 week period in 2018.
- Undertake annual quoll trapping at Quoll Knoll complex in conjunction with feral animal control program in July 2018.
- Explore the opportunities to undertaking genetic lineage research, from existing DNA samples, and by using mother/offspring DNA as a census of individuals in the area each year.
- Survey (remote cameras and scat searches) additional areas nearby to Quoll Knoll for quoll presence. Areas, such as Coonarrie Creek, Bea Bea Creek and Cockeraga

Creek where evidence of quolls was found in 2014, and additionally the previously inaccessible granite and tor piles near Roy Hill chainage 182.

1 Introduction

This report details the research undertaken by the Department of Biodiversity, Conservation and Attractions (DBCA) in 2017 on northern quoll populations and distribution within the Chichester Ranges. The research is part of Roy Hill's Northern Quoll Research Plan (NQRP) (100RH-3000-EN-REP-2033) as part of the requirements of Condition 3 of *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) approval 2011/5867. This work conducted in 2017 is a continuation of previous survey efforts throughout the area (Johnson and Anderson, 2014; Dunlop *et al.*, 2015; Dunlop and Johnson, 2016). The results of this and previous surveys are summarised and discussed.

1.1 Northern quoll *Dasyurus hallucatus*

The northern quoll is a medium-sized predatory marsupial, the smallest of Australia's four species of *Dasyurus* (Oakwood, 2002a). Northern quolls were once widely distributed from the Pilbara and Kimberley in Western Australia, across the Top End to southern Queensland, but have now contracted in distribution and density to several disjunct populations within their former range (Braithwaite and Griffiths, 1994). In 2005, the northern quoll was listed as an Endangered species under the Commonwealth's EPBC Act 1999 (Oakwood *et al.*, 2008; Department of Sustainability, 2011). This was due to an alarming decrease or complete collapse of some of the once locally abundant populations in Queensland and the Northern Territory, and a subsequent contraction of its range (Oakwood *et al.*, 2008). In particular, northern quolls have declined at a rapid rate in association with the spread of the introduced cane toad *Rhinella marina*, which poisons quolls in their predation attempts. Several other ecological factors are contributing to the decline of quolls and other medium-sized mammal fauna, including predation by feral cat (*Felis catus*), wild dogs (*Canis lupus*), altered fire regimes, grazing and subsequent habitat modification by introduced herbivores, habitat loss and fragmentation, as well as the cumulative and interactive effects between these (Braithwaite and Griffiths, 1994; Hill and Ward, 2010; Woinarski *et al.*, 2014).

Northern quolls inhabit a variety of areas, including rocky outcrops and ridges, rainforests, eucalypt forest and woodland, sandy lowlands, shrublands, grasslands, and desert (Department of Sustainability, 2011; Cook and Morris, 2013). In the Pilbara, northern quolls appear to depend primarily on more complex rocky habitat (Molloy *et al.*, 2017) than northern quolls in the Northern Territory or Queensland, where tree hollows and logs are common (Oakwood, 1997). The ridges and mesas of channel-iron deposits and banded iron formations are often the primary focus of iron-ore extraction in the Hamersley Province (Morris and Ramanaidou, 2007), while granite outcrops are often quarried for road and rail beds. For this reason, Pilbara northern quolls are recognised as specially protected fauna by the EPBC (1999), due to the likelihood that the species will be impacted by the removal or alteration of habitat by mining activity and associated infrastructure development.

Although they are primarily carnivorous, feeding on invertebrates and small vertebrates, northern quolls will also opportunistically eat eggs and fleshy fruit or scavenge on roadkill or waste (Dunlop *et al.*, 2017). Northern quolls are sexually dimorphic, with males tending to be larger than females (Oakwood, 2002b). The species is the largest animal in the world to undergo suicidal reproduction (semelparity), whereby males experience immune system

collapse and eventual death, usually in the first year, after an intense mating period (Oakwood *et al.*, 2001; Fisher *et al.*, 2013). This enables females to drive intense competition between males, and allow females and their young to have access to maximum food abundance during the period of pouch young development and dispersal (Fisher *et al.*, 2013). Females breed synchronously over a period of months, when 6-8 young are born, grow in the pouch and are deposited in dens after eight to nine weeks (Oakwood, 2002a).

While the biology and ecology of the northern quoll has been studied in the Northern Territory (Begg, 1981; Braithwaite and Griffiths, 1994; Oakwood, 1997; Oakwood, 2000; Oakwood, 2002b) and to a lesser extent in the Kimberley (Cook, 2010; How *et al.*, 2009; Schmitt *et al.*, 1989), few studies have been undertaken on northern quolls in the Pilbara. Due to the limited evidence available to allow for the creation of ecologically equivalent offsets (Department of Sustainability, 2011) for the northern quoll in the Pilbara, a proportion of offset funds for this species has been directed towards scientific research. DBCA has also implemented a Pilbara-wide quoll research program (Cramer *et al.*, 2016) to provide a regional context for more targeted population research.

1.2 Roy Hill EPBC Requirements

Roy Hill Infrastructure Pty Ltd (Roy Hill) has Commonwealth and WA Office of Environment Protection Authority approval for the Roy Hill Rail and Associated Infrastructure Project (the Rail Project) which comprised the construction and operation of a recently completed heavy-haul standard gauge railway line approximately 344km in length connecting the Roy Hill Mine to Port Hedland, in the Pilbara Region of Western Australia. The Rail Project also incorporates the construction of support infrastructure such as a permanent access road running the length of the rail alignment, additional construction roads, bridges, passing sidings, workshops, borrow and ballast areas, lay down areas and four temporary construction workforce camps. Since construction was completed in late 2015 and operations have started, camps, borrow pits and other temporary construction sites are in the process of being demobilized and will be subject to rehabilitation.

The project was referred to the Department of Sustainability, Environment, Water, Populations and Community (DSEWPaC) and conditions were imposed (EPBC 2011/5867) due to the impact on listed species under the EPBC Act, including the northern quoll. In response to this approval, Roy Hill developed a Northern Quoll Research Plan (NQRP) (Roy Hill Holdings Pty Ltd, 2014).

The NQRP has been designed to align with the DBCA Pilbara northern quoll regional research program (Dunlop *et al.*, 2014). The specific objectives of the NQRP include:

- To improve the understanding of the northern quoll distribution, ecology, and abundance and other demographic parameters in the Chichester Ranges and allow comparison with other studies in the Pilbara;
- To inform management for the conservation of northern quoll populations in and around mining sites and other developments in the Chichester Ranges; and
- To help clarify the genetic and conservation status of the Chichester Ranges northern quoll population.

1.3 Previous Surveys

Significant effort has been made in recent years to determine the presence and extent of northern quolls within the Chichester Ranges (Biota Environmental Sciences, 2005; Davis *et al.*, 2005; Ecologia Environment, 2008). Previous surveys indicate that populations of northern quolls in the eastern part of the Chichester Ranges appear to be highly fragmented with small breeding colonies occupying relatively isolated islands of suitable refuge and foraging habitat. Northern quolls have not been detected at a number of sites that appeared to meet the requirements for suitable quoll habitat (substantial complex rocky habitat with prey resources available) during previous surveys (Johnson and Anderson, 2014). Quoll populations appear to increase further north and west of this study area (Coffey Environments, 2012; Rapallo, 2012). DBCA established two long-term monitoring sites at more westerly Chichester Range sites, Mt Florance and Python Pool, in 2014, both of which have consistent quoll presence.

A small population of northern quolls was discovered in 2014 at a rock outcrop complex referred to as 'Quoll Knoll', within the Roy Hill Special Rail Lease (SRL). Quoll presence was initially confirmed by Phoenix Environmental as part of the Roy Hill Fauna Trapping and Translocation Program in April 2014 (Roy Hill Holdings Pty Ltd, 2014). Three individuals were trapped by DBCA in September 2014 as part of a targeted northern quoll survey in the central and eastern Chichester Ranges (Johnson and Anderson, 2014). Monitoring using cage trapping and camera traps has confirmed intermittent occupation of the Quoll Knoll complex between August 2014 and June 2016. A total of five individuals were trapped during this time; two females and a male initially caught in 2014, one new male and one new female caught in 2015 with only one female recapture from the previous year. During the 2016 monitoring survey, no quolls were trapped over the 40 trap-night effort, however a large male feral cat was subsequently trapped and euthanised with gut contents determined to consist entirely of northern quoll. It was presumed that this predation event caused the local extinction of the small population, with the last evidence of quolls occupying Quoll Knoll captured on the 8th of July 2016 by Roy Hill staff on one of the four permanent camera trap stations deployed at Quoll Knoll and its surrounds (Dunlop and Johnson, 2016).

The northern quoll population at Quoll Knoll is considered significant due to the low density and sparse spread of quoll populations, as well as large distances between suitable habitat in this area. Quolls are generally less abundant in the south-eastern Pilbara (see Ecoscape, 2017; Molloy et al., 2017) and this colony is close to the south-east limit of quoll populations. Monitoring and feral animal management should continue to be of high priority to facilitate recolonization of dispersing quolls to the complex.

The nearby Mesa 228 (Figure 1, approximately 1.5km south from Quoll Knoll) was chosen to be included as a survey site due to its proximity to the Quoll Knoll population, size of suitable habitat and complexity of breakaway habitat. One individual male northern quoll was captured at Mesa 228 in 2015, but there have been no further records in three years of monitoring.

The gorge at Wall Creek (Hooley Station, Figure 1) was also chosen as a monitoring option due to the presence of good northern quoll habitat parameters including permanent water, rugose gorge walls, minimal disturbance, and generally intact vegetation. However, no individuals were captured in 2015 or 2016 (Dunlop *et al.*, 2016). From 828 camera nights, only one photo of a single individual at Wall Creek was captured in 2016. Evidence of quolls

have been recorded through scat searches in 2014 at other nearby sites including Coonarrie Creek, Bea Bea Creek and Cockeraga creek, located at 36.5 km, 19 km and 12.4km from Wall Creek respectively (Figure 2).

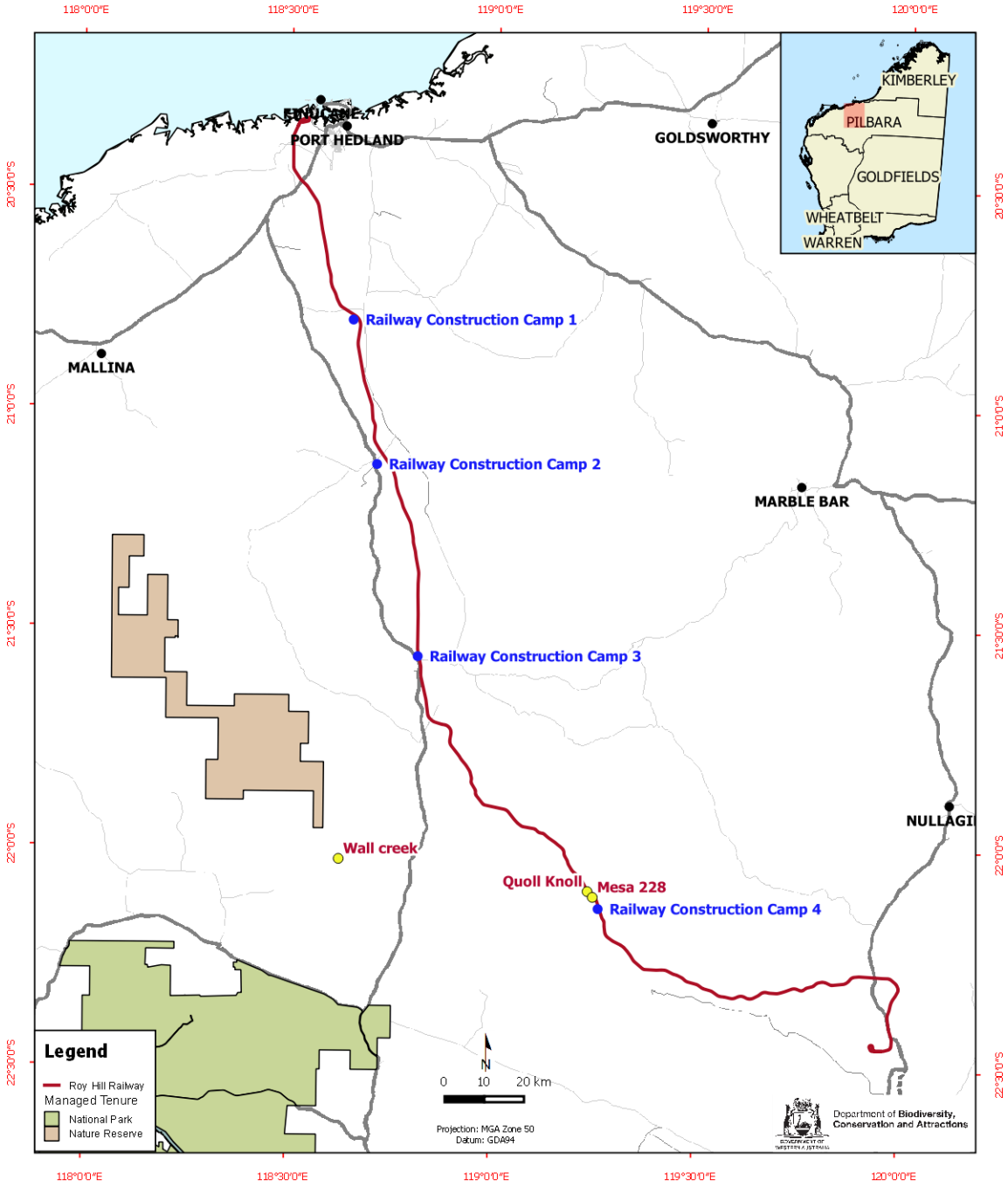

Figure 1. Map of the 2017 Roy Hill northern quoll camera and cage trapping sites (Wall Creek, Mesa 228 and Quoll Knoll) in the context of the Pilbara, showing Roy Hill Railway and the currently unoccupied Rail Camps 1- 4.

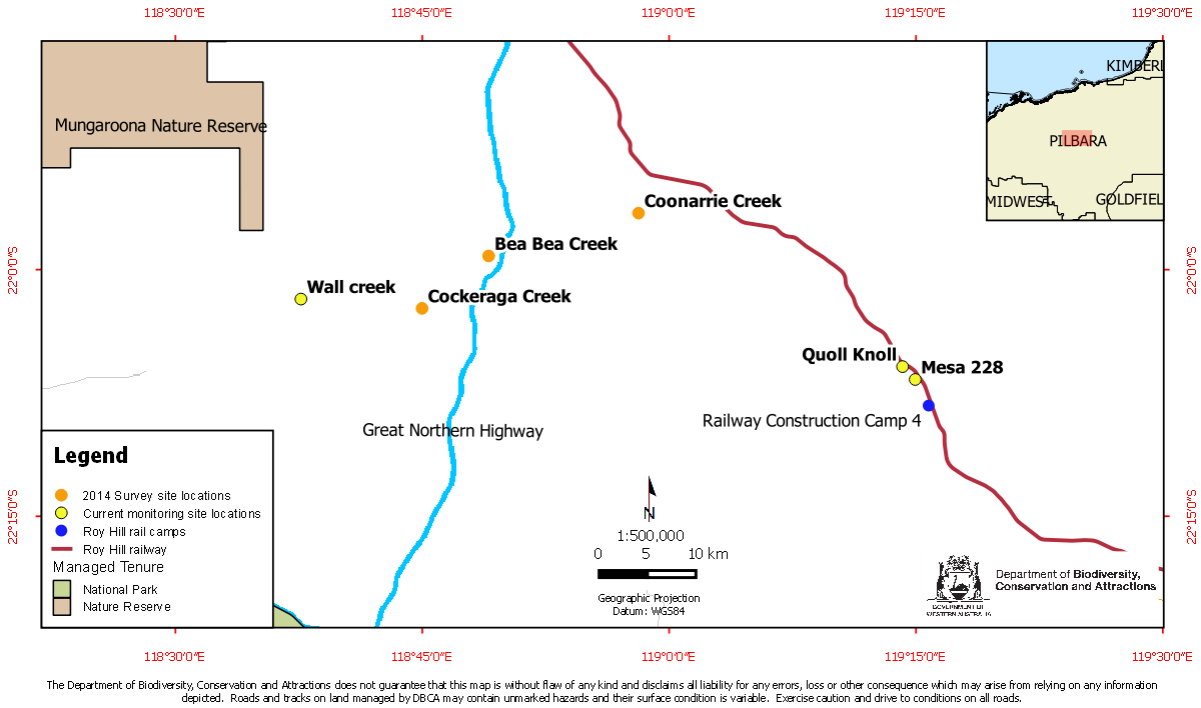

Figure 2. Map of previous survey sites in 2014 where evidence of quolls was discovered through camera traps and scat searches in relation to current monitoring site locations. Orange dots signify the 2014 locations, yellows dots denote current monitoring sites.

2 Methods

2.1 Sites and site conditions

Wall Creek on Hooley Station (Figure 3) is a long rocky gorge running approximately north-south, eventually feeding into the Yule River to the north. The gorge is shallower at the southern end and becomes deeper and more complex to the north. The habitat consists of a scree slope of weathered rocky basalt with numerous permanent pools of water in a creek line at base of the slope, mixed vegetation complex with *Triodia* sp., *Eucalyptus* sp., *Acacia* sp., *Melaleuca* sp., and other shrub species. The upper slopes of the gorge consist of open woodland of *Triodia* sp. and mulga (*Acacia aneura* and related *Acacia* species). It is recognised to have both ecological and Aboriginal significance, and was prioritised to remain undisturbed during the FMG rail construction (Fortescue Metals Group, 2010).

Figure 3. Weathered rocky basalt scree slope with mixed vegetation complex at Wall Creek, Hooley Station.

Figure 4. Rocky breakaway habitat on the ridge that forms Mesa 228.

Mesa 228 (Figure 4) is a long lateritic ridge mesa, approximately 900m long with numerous caves and crevices along the upper breakaway ridge. Vegetation includes *Triodia* sp., *Eucalyptus* sp., and other shrubs surrounding and on top of ridge. The intermittent breakaways in this area were identified as potential northern quoll habitat during fauna surveys (Roy Hill Holdings Pty Ltd, 2011).

The rocky knoll dubbed “Quoll Knoll” is approximately 1.5km to the north of Mesa 228, next to and between the Roy Hill rail line and a light vehicular access track (Figure 5). Quoll Knoll is a small (200 m x 100m) lateritic outcrop of very large boulders, bounded by the railway cutting on one side, and with a vehicular track between the rocky areas. Vegetation includes *Triodia* sp. and other shrub species, with a creek line at the base of the outcrops containing a mixed vegetation composition including dominant *Acacia* species (Phoenix Environmental Sciences, 2011).

Figure 5. The small rock outcrop referred to as Quoll Knoll. It lies directly between the Roy Hill rail line and Rail Service Track used by light vehicles.

Climatic data were collated from the nearest BOM weather station (Wittenoom station 005026), Wittenoom, located 38km from Wall Creek and 95km from Mesa 228. The monthly averages of rainfall and temperature from 1951 to 2016 are shown in Figure 6. The Pilbara experiences the majority of its rainfall during monsoonal rainfall events over summer, with cool and dry winters. The region received higher than average summer rainfall over the first three months of 2017, with little to no rainfall between May and October. There was little difference in 2017 minimum and maximum temperatures when compared to the long-term averages.

Table 1. Site locations and survey effort for the 2017 field season.

	Latitude	Longitude	Cage trap nights	Camera trap nights	Set date	Retrieval date
Wall Creek	-22.02791	118.6282	0	1010	30/4/17	9/8/17
Mesa 228	-22.11425	119.2458	0	1230	28/4/17	29/8/17
Quoll Knoll	-22.09658	119.2368	40, plus ~250 cat cage trap nights	1263		

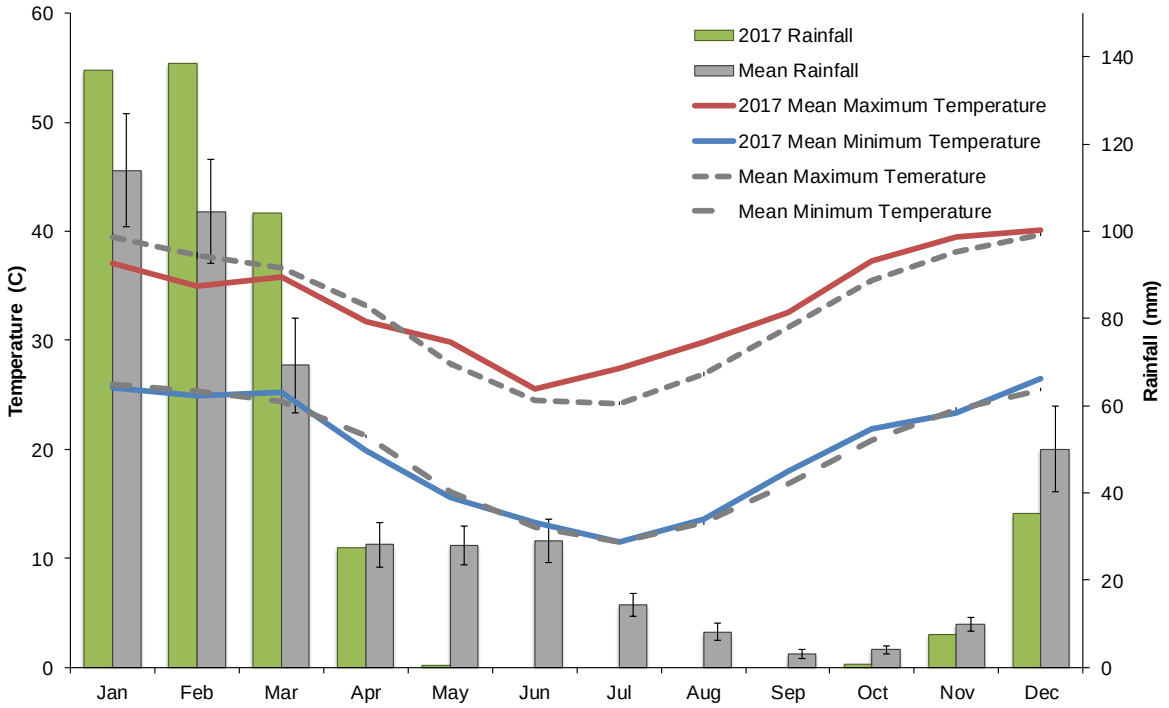

Figure 6. Climate data for the nearest Bureau of Meteorology weather station, Wittenoom station (005026). Grey columns indicate the 50-year mean monthly rainfall, grey lines indicate the 50-year mean monthly minimum and maximum temperatures, and coloured columns and lines are 2017 data for comparison.

2.2 Camera trapping

Motion-sensing camera traps (Reconyx PC900) were used as a low impact quoll detection method at each site. Cameras were set to record activity at all times of day and night with five consecutive photographs per trigger. The cameras were fixed to a stable object such as a tripod, tree or rock, in front of a scent lure consisting of peanut butter, oats, sardines and fish oil in an inaccessible ventilated pod. Cameras were set approximately 100m apart in order to spread detections across as many home ranges (usually delineated by females) as possible. Ten camera traps were deployed at both Mesa 228 (28 April – 29 August) and Wall Creek (30 April – 9 August) for a total of 1230 and 1010 camera nights respectively. For analysis purposes, an occasion was defined as a visit by a species on one camera in a 24-hour period. If multiple individuals were able to be identified (e.g. multiple animals in an image, or differently patterned individuals), this was recorded. In addition to this, since April 2014, Roy Hill have four permanent, unbaited camera traps set at Quoll Knoll and on the two smaller knolls to the west of the LV track (Knoll 2 and Knoll 3), plus a camera located at a quoll latrine site under the West Shaw River rail bridge. These are all located at Roy Hill railway chainage 225 to monitor the presence of northern quolls.

Analysis of photographs was done through importing photos into CPW Camera Warehouse (CPW) for species identification as well as identification of individual quolls through unique pelage marks. To determine individual identification, each quoll detection event needed to be determined, this was defined as a series of photographs with no more than a 15-minute interval between successive photographs of a quoll (Diete *et al.*, 2015). All detection events

were examined to confirm that only one individual was captured on the series of photographs assigned to the event; if a second individual was found to be within the event then photographs were split and assigned their own event.

Once all quoll detections were defined appropriately, individuals were determined through a combination of manual identification and Wild ID (Bolger *et al.*, 2012). Each new individual was given a unique identifying ID and then reference photographs were compiled and put into a ID book for ease of comparison. Given that the animals entered the camera field of view at different angles and positions, some identifications were not as confidently determined as others. We therefore provide an estimated range of possible individuals detected.

2.3 Cage trapping

Targeted feral cat trapping also occurred along the Roy Hill SRL near Quoll Knoll, undertaken at the time of the northern quoll survey in autumn (April 2017) and spring (September 2017). This feral animal control program was conducted by Aussie Feral Pests (AFP). Large cage traps baited with chicken and/or tinned cat food were strategically placed in likely cat habitat or where cat tracks were observed, for five nights. Traps were repositioned as new cat tracks are discovered. Any northern quolls incidentally captured in cat traps were scanned for a microchip, measured and released.

DBCA staff undertook trapping at Quoll Knoll totalling 40 trap nights (28 April – 2 May 2017) using wire cage traps. All captured quolls are implanted with a subcutaneous microchip (PIT) for individual identification. Standard measurements collected from any captured quolls and other species include: body weight, short pes length, head length, age class, sex, body and reproductive condition. Animals are only measured on their first capture. Weights were sometimes re-measured on subsequent captures to ensure that animals were not losing body mass due to stress/lack of foraging during the trapping process. A small amount of ear tissue is collected from each individual of all species at initial capture and stored in 100% ethanol for genetic analysis. Animals are examined for ectoparasites, especially around the ears, neck and genitals.

2.4 Dietary analysis

Quoll and feral predator scat searches were undertaken at the trapping sites and several other areas on an opportunistic basis. Searches were undertaken with personnel spending several hours walking through likely habitat (breakaways, creek systems, mesas and ridges) examining rocky crevices and caves. Scats were collected and stored in a paper envelope with associated data (GPS location, date, species, collector). Once dry, scats were kept frozen until sent for analysis to a specialist (G. Story, Scats About, NSW) where food types were recorded for each scat and a percent volume of each food item within the scat was visually estimated using a grid system.

Scats and gut contents were oven-dried at 100°C for 12 hours to kill parasite eggs. Samples were then placed in individual fine weave nylon bags, washed in a washing machine and air-dried. Food items were identified via microscopy from the undigested parts of plants and animals, including hair, teeth, claws, scales, feathers, bones and exoskeletal remains. Food items were recorded for each scat and a percent volume of each food item within the scat was visually estimated using a grid system. Food items were identified to the lowest

possible taxonomic class through comparison of remains with reference material or the literature (Brunner and Triggs, 2002). Hair was identified to species from characteristics of the hair scales, patterning and shape when cross-sectioned as per Brunner and Coman (1974).

Scat searches were undertaken at all trapping sites (Wall Creek, Mesa 228, Quoll Knoll) as well as nearby likely habitat (creek systems, under rail bridges). Daniel Reed from AFP worked with the DBCA northern quoll survey team as he was undertaking feral animal control in/around Quoll Knoll during April 2017.

3 Results

3.1 Camera traps

Three different individual quolls were detected from six occasions at Wall Creek, from 1010 camera trap nights (Figure 7). A total of 17 species were detected at Wall Creek over the deployment period, notably with no introduced feral predators detected over the deployment period (**Error! Reference source not found.**). Other species included 34 detections of c ommon rock-rat (*Zyzomys argurus)*, at least four species of bird and three species of varanids.

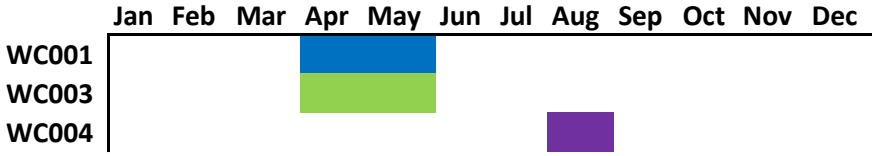

Figure 7. Detection history of each individual of northern quoll at Wall Creek over the 2017 deployment period. Block colours indicate at least one detection of an individual in the corresponding month.

The array at Mesa 228 identified 26 fauna species over 1230 trap nights, with no quolls detected during this period. Several introduced predators were present at this site; there were three feral cat, three fox and three dingo detections (*Figure* 12, *Figure 13*, *Figure 14*). Other detections include, 84 occasions of *Pseudantechinus sp.*, 218 occasions of common rock-rats, seven occasions of short-beaked echidnas (*Tachlyglossus aculeatus*) as well as five bird and at least 12 reptile species identified (

).

The permanent unbaited cameras placed around Quoll Knoll and its surrounds identified at least four quoll individuals from 167 occasions, as well 15 *Pseudantechinus sp*. and 61 common rock-rat detections over 1263 trap nights (*Figure 8*). There was only one detection of a feral cat at Quoll Knoll, with no evidence of any other introduced feral predators seen during the 2017 deployment

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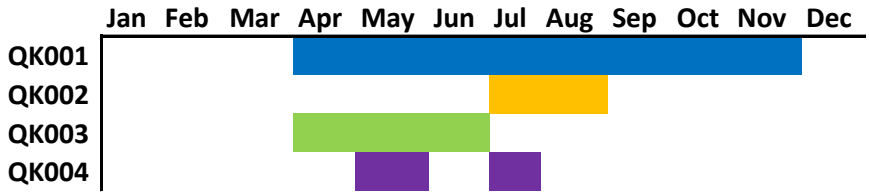

Figure 8. Detection history of each individual northern quoll at Quoll Knoll over the 2017 deployment period. Block colours indicate at least one detection of an individual in the corresponding month.

Table 2. Species detected from camera traps set at Wall Creek (WC), Mesa 228 (ME) and Quoll Knoll. An occasion was defined as a visit by a species to a camera in a 24h period; numbers in this table indicate the number of detection occasions for that species at each site. See (*Table 1*) for set durations and locations.

Common name	Scientific name	Mesa 228	Quoll Knoll	Wall Creek
Dingo	*Canus lupus dingo*	3	0	0
Feral cat	*Felis catus*	3	1	0
Red fox	*Vulpes vulpes*	3	0	0
Northern quoll	*Dasyurus hallucatus*	0	167	6
Pseudantechinus	*Pseudantechinus sp.*	84	15	0
Common rock rat	*Zyzomys argurus*	218	61	34
Red kangaroo	*Macropus rufus*	0	2	0
Common Wallaroo	*Macropus robustus*	20	10	10
Rothschild's Rock Wallaby	*Petrogale rothschildi*	0	0	3
Echidna	*Tachyglossus aculeatus*	7	6	0
Macropod	-	0	5	4
Rodent	-	0	7	0
TOTAL MAMMAL SPECIES		**7**	**9**	**5**
Striated Grasswren	*Amytornis striatus*	0	25	0
Crow	*Corvus sp*	30	1	21
Butcher bird	*Cracticus nigrogularis*	5	1	1
Blue-winged Kookaburra	*Dacelo leachii*	0	1	0
Painted Finch	*Emblema pictum*	7	5	0
Diamond Dove	*Geopelia cuneata*	1	1	0
Spinifex Pigeon	*Geophaps plumifera*	0	19	0
Magpie-lark	*Grallina cyanoleuca*	0	20	2
Yellow-throated Miner	*Manorina flavigula*	0	0	1
Willie Wagtail	*Rhipidura leucophrys*	17	7	0
Unidentifiable Bird	-	0	7	1
TOTAL BIRD SPECIES		**5**	**9**	**4**
Long-nosed dragon	*Amphibolurus longirostris*	0	2	0
Black-Headed Python	*Aspidites melanocephalus*	0	1	0
Ctenophorus	*Ctenophorus sp.*	1	0	0
Ctenotus	*Ctenotus sp.*	25	13	0
Spiny-tailed Skink	*Egernia epsisolus*	0	1	0
Egernia	*Egernia sp.*	0	1	0
Lined fire-tailed skink	*Morethia ruficauda*	1	0	0
Spiny-tailed monitor	*Varanus acanthurus*	16	3	0
Perentie	*Varanus giganteus*	8	24	1
Pilbara Rock Monitor	*Varanus pilbarensis*	21	11	1
Varanid	*Varanus sp.*	6	1	2
Gecko	-	1	3	0
Python	-	1	0	0
Reptile	-	6	1	3
Skink	-	5	0	3
Snake	-	4	2	0
TOTAL REPTILE SPECIES		**12**	**12**	**5**
Frog	-	0	0	1
Invertebrate	-	5	2	0

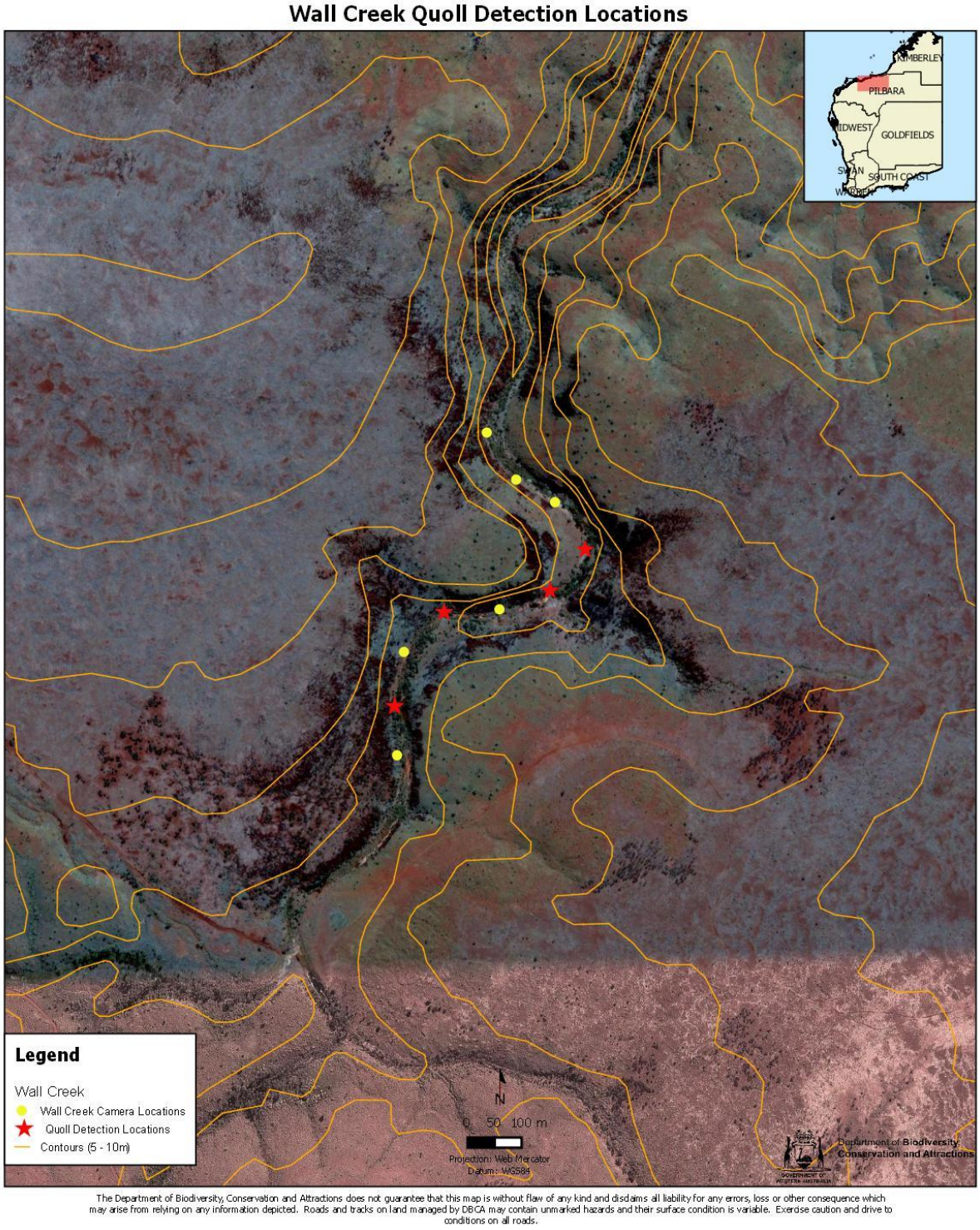

Figure 9. Map depicting 10 camera trap locations as well as detection locations of northern quoll during the 2017 camera deployment at Wall Creek on Hooley Station. The red stars denote the northern quoll detection locations and the yellow dots denote the remainder of the camera locations.

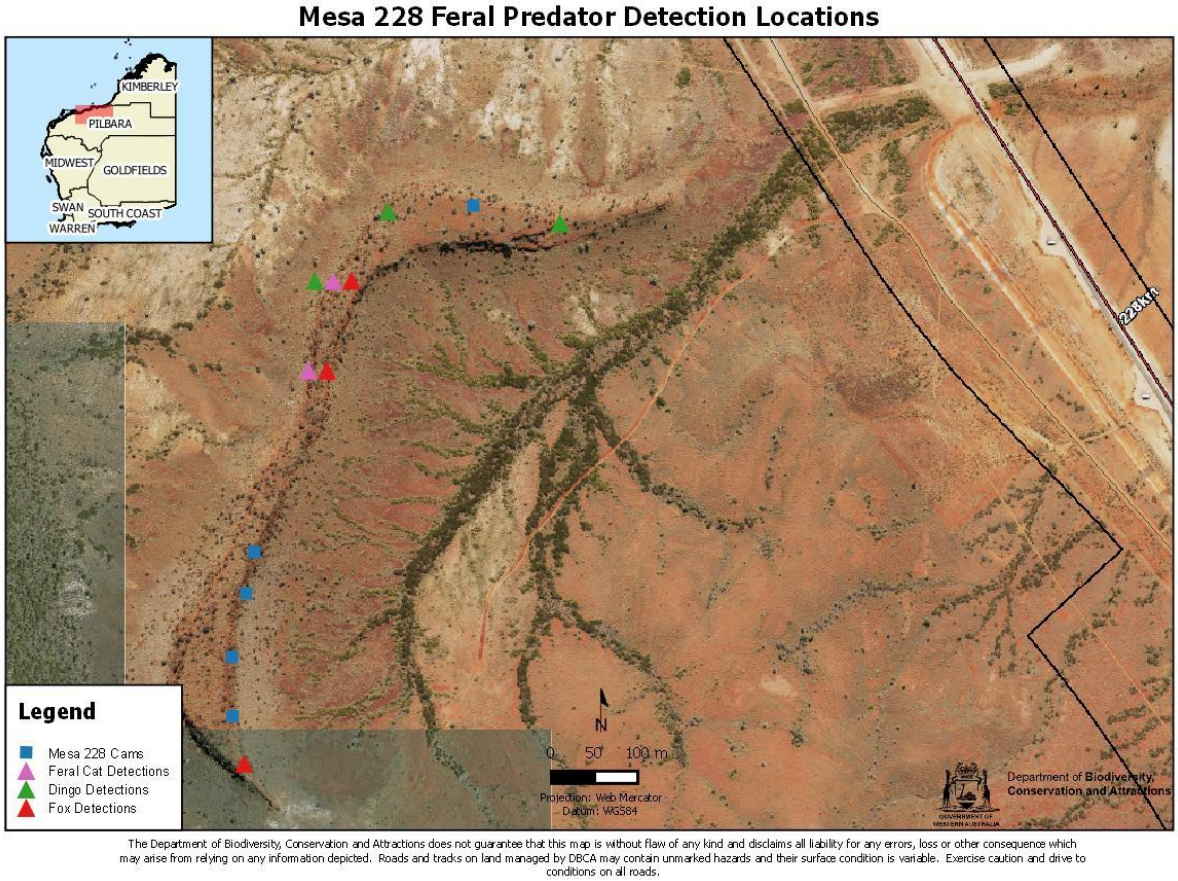

Figure 10. Map depicting 10 camera trap locations and detection locations of introduced feral predators at Mesa 228. Triangles denote the locations of predator detections, pink for feral cats, red for fox and green for dingo. The blue squares denote the rest of the camera locations.

3.2 Cage trapping

Two individual quolls were captured at Quoll Knoll, one adult male and one adult female during the April 2017 trapping session. Both animals were new individuals that had not previously been trapped and microchipped. One female house mouse (*Mus musculus)* was captured, but no common rock-rats (*Zyzomys argurus*) were captured.

Non-target capture of quolls through feral cat management resulted in the capture of two quolls over approximately 250 trap nights between November 2016 and December 2017. One individual was trapped in the November 2016 trapping session (18 – 23 November) and a female caught in the April/May 2017 Quoll Knoll trapping session was caught again on the 19th September 2017 by AFP during a feral cat control session.

Table 3. Species detection history for the three sites. Captures during the three-year period included northern quolls (*Dasyurus hallucatus*), Common rock rats (*Zyzomys argurus*) and House mice (*Mus musculus*). Trap nights with an asterisk* refer to camera traps rather than cage traps.

	Captures	2015	2016	2017
Wall Creek	Quoll	0	0	3
	Rock rat	1	3	-
	House mouse	1		
	Trap Nights	*200*	*200*	*1010**
Mesa 228	Quoll	1	0	0
	Rock rat	17	18	1
	House mouse	0	0	0
	Trap Nights	*200*	*200*	*1230**
Quoll Knoll	Quoll	3	0	2
	Rock rat	0	1	0
	House mouse	0	0	1
	Trap Nights	*40*	*40*	*40*

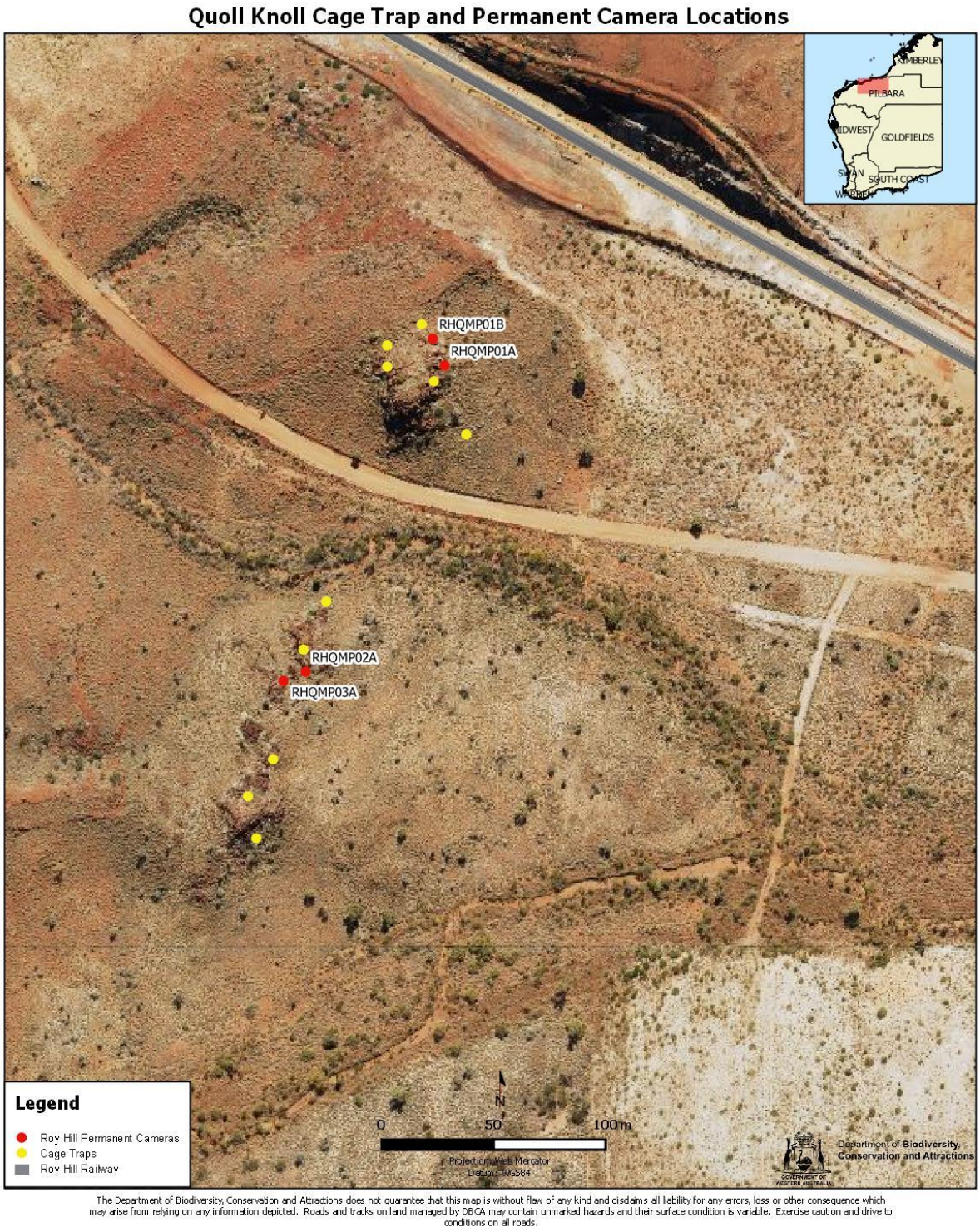

Figure 11. Map depicting Roy Hill permanent camera locations and cage trap locations from the April-May trapping session at Quoll Knoll. Red dots indicate the permanent camera locations, yellow dots denote the camera trap locations.

3.3 Dietary analyses

Three scat samples were taken from the two individual quolls captured at Quoll Knoll, as well as a group of scats collected from a latrine site under the West Shaw River rail bridge near Quoll Knoll (RHQMP05A). Scats were not found during searches when deploying and retrieving cameras at Wall Creek or Mesa 228. No feral cat gut contents were retained for analysis during 2017.

Analysis of the four northern quoll scat samples did not reveal any unusual dietary items (Table 4). Quolls at these sites primarily consumed invertebrates (22.5%) and fruit (22.5%), with opportunistic captures of vertebrates (birds and skinks).

Table 4. Percentage volume of occurrence of different northern quoll dietary items from scats collected at Mesa 228 and Quoll Knoll.

Date	Lat	Long	Site	**Bird**	**Skink**	**Beetle**	**Grass-hopper**	**Ant**	**Fruit**
4/7/17	-22.044	112.159	Latrine site	50	0	0	40	10	0
29/4/17	-22.097	119.237	Quoll Knoll	0	90	0	0	10	0
29/4/17	-22.097	119.237	Quoll Knoll	0	0	5	0	5	90
2/5/17	-22.098	119.236	Quoll Knoll	0	80	0	0	20	0

4 Discussion

Quolls were present at two of the three study sites; Quoll Knoll and Wall Creek. Quoll Knoll suffered a local extinction in 2016-2017 for approximately nine months but was successfully recolonised by dispersing sub-adult animals in April 2017. This area contains small, disjunct quoll populations, separated by several kilometres of unsuitable habitat. Continued monitoring program being undertaken by Ecoscape for Fortescue Metals Group at the nearby Cockeraga Creek (12.4 km from Wall Creek) has recorded ongoing presence of northern quoll in this section of the Chichester Range, although with only a small population density in this area (D. Cancilla *pers. com.* 2017).

Multiple quolls were detected at Wall Creek for the first time in 2017. Three individuals could be identified, intermittently occupying the area during April, May and August 2017. Multiple detections of the same animals may indicate that they were resident at Wall Creek during this period. Prior to this, a single northern quoll was detected on a single camera trap from 828 camera trap nights at Wall Creek in 2016. Quolls have been recorded at other nearby sites included Coonarrie Creek, Bea Bea Creek and Cockeraga creek, located at 36.5 km, 19 km and 12.4km from Wall Creek respectively.

There was no evidence of northern quolls using Mesa 228 as foraging or denning habitat. In the last three years, the only record of northern quolls at this location was one capture of a large adult male in 2015. Several introduced predator species using Mesa 228, including feral cats, red fox and dingoes were recorded in 2017.

There was high overall species diversity captured by camera traps at all sites, with 31 mammals, reptiles and birds identifiable to species level. Mesa 228 had highest level of diversity, with 24 identifiable species compared to 14 at Wall Creek. No additional species were detected via scat analysis.

Analysis of northern quoll diet did not reveal unusual results, however there was a small sample size from these sites due to low northern quoll population density. Quolls at these sites primarily consumed invertebrates (22.5%) and fruit (22.5%), with opportunistic captures of vertebrates (birds and skinks), a finding similar to previous Pilbara northern quoll dietary analyses (Dunlop *et al.*, 2017).

Feral predators were not commonly detected at any of the sites during 2017. During approximately four months of camera trapping at Mesa 228 and Wall Creek, there were three detections of feral cats at Mesa 228, and none at Wall Creek. Only one occasion of a feral cat was detected by the Quoll Knoll permanent camera array in 2017. One individual cat was trapped by AFP during feral predator management during 2017 from three trapping sessions. While vertebrate species were found within the gut content of the cat, no quoll remains were observed (Reed, 2017). Foxes were recorded for the first time at these sites this year, with a fox present at Mesa 228 in May and June of 2017. In 2016, high visitation by feral cats and dingoes may have contributed to the lack of northern quoll population which was evident from camera trap data from July 2016 to August 2016.

Areas with permanent water such as Wall Creek may operate as a sink for larger predators in drier years. Predation by feral cats is recognised to be a primary threatening process to northern quolls, along with poisoning by invasive cane toads and inappropriate fire regimes (Woinarski *et al.*, 2014). Feral cats have been identified to feed on at least 400 vertebrate

species in Australia, including 28 species identified as threatened under IUCN listing (Doherty *et al.*, 2015). Feral cats have been linked to the extinction of 63 species worldwide (Doherty *et al.*, 2016). Recent examinations of the interaction between feral cats and northern quolls in the Pilbara demonstrate that feral cats most frequently used flat, open habitats, and that northern quolls avoided areas used by cats (Hernandez-Santin *et al.*, 2016). However, some habitat use overlap occurs, and feral cats have been observed to predate on Pilbara northern quolls, with six of 41 collared northern quolls being killed by cats in a six-month period (Morris *et al.*, 2015). In addition, northern quoll fur was found in the stomach contents of a feral cat captured at Quoll Knoll in 2016 (Dunlop and Johnson, 2016). It is likely that introduced predators such as feral cats prevent northern quolls from using some areas of the landscape, both at a local and broader scale. Predator avoidance has been suggested to explain the contraction of the distribution of northern quolls to rocky areas across northern Australia (Hernandez-Santin *et al.*, 2016).

Suitable refuge habitat for northern quolls in the eastern Chichester ranges appears to be small and widely dispersed throughout the landscape, making northern quolls vulnerable to predation when moving between habitats, or dispersing following recruitment. Pilbara populations of northern quolls have pouch young present from August – October (variable according to rainfall), den young between November and February, and young emerge and disperse from February – April. Predation upon juveniles has the most impact on northern quoll populations (Moro *et al.*, 2015), and their naivety probably makes them more vulnerable to predation. Therefore, targeted cat trapping should occur at times of northern quoll denning, mating and dispersal (Table 5).

Table 5. Months of northern quoll and feral cat activity to inform management actions

Activity	Months (may vary between years according to season)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Northern quoll pouch young												
Northern quoll denning young												
Northern quoll young dispersal												
Northern quoll mating												
Low prey availability for feral cats												
Feral cat trapping												
Feral cat baiting												

5 Recommendations

The following actions are recommended:

- Roy Hill to continue permanent passive camera trap work at Quoll Knoll complex, West Shaw River Rail bridge (RHQMP05A) latrine site. Review images for northern quoll records, feral cat and fox records. These images and locations of capture to be provided to the Roy Hill feral pest contractor prior to each feral animal control event to enable a targeted control program.
- Roy Hill to continue feral cat control via cat trapping at Quoll Knoll and rail corridor area in order to make this habitat available for individuals to recolonise. Cat control should be undertaken in February-March, June-July and September-October in order to target times of quoll dispersal, lowest prey availability for cats (i.e. cats are more likely to enter traps during these times) and denning of young (respectively). Any quolls trapped to be microchipped, processed, photographed for individual identification and data provided to DBCA.
- Roy Hill to implement fox control at the sites where foxes are detected on camera traps (e.g. Mesa 228 in 2017) and undertake active searches for fox evidence in the vicinity of Quoll Knoll and conduct trapping accordingly.
- Once the operational use of *Eradicat*® baiting in the Pilbara is approved by the APVMA and DBCA, Roy Hill should bait along their rail line in a buffer (e.g. 10km) around Quoll Knoll in conjunction with trapping efforts. *Eradicat*® would be used as per standard recommendations (maximum density of 50 baits per square km, avoiding public access roads, notifying other landholders, with appropriate 1080 permits, in coldest months of the year when young quolls are not present).
- RH and DBCA collaboratively undertake a trial of the Felixer feral cat grooming trap, subject to APVMA and other approvals, as per the Felixer research agreement.
- RH and DBCA collaboratively monitor quolls at Quoll Knoll, and to be undertaken by quoll trapping at the same time as mid-year cat trapping.
- RH and DBCA collaboratively to continue to monitor Wall Creek via camera traps for monitoring quoll and introduced predator densities at least for a 4-6 week period.
- DBCA to explore the potential for a genetic lineage research project requiring trapping when quolls are carrying pouch young.

Roy Hill currently supports the trapping of two Chichester Ranges sites incorporated in the DBCA regional monitoring program (Euro springs on Mt Florance Station and Python Pool, within the Millstream-Chichester National Park), and data from these two sites are reported separately in the annual report for this regional monitoring program.

Appendices

Appendix 1. Camera trap detections

Figure 12. Fox captured on camera trap at Mesa 228, 5 July 2017

Figure 13. Canid captured on camera trap at Mesa 228, 8 July 2017

Figure 14. Feral cat captured on a permanent unbaited camera trap at Quoll Knoll, 11 August 2017 (Image provided by Roy Hill)

Figure 15*.* Northern Quoll captured during daylight hours on a permanent unbaited camera trap at Quoll Knoll, 6 September 2017 (Image provided by Roy Hill).

Figure 16. Echidna captured on remote camera on Mesa 228, 19 May 2017

Figure 17. Pseudantechinus sp, captured on remote camera at Mesa 228, 14 August 2017

Figure 18. Northern quoll captured on remote camera at Wall Creek, 30 April 2017

Appendix 2. Camera trap locations

Table 6. Locations and dates of individual camera traps set for northern quoll and feral species detections, locations are given in decimal degrees.

Location	Camera	Lat	Long	Start date	End date	Set Days
Mesa 228	38	-22.1114	119.2491	28/4/17	29/8/17	123
Mesa 228	40	-22.1112	119.2481	28/4/17	29/8/17	123
Mesa 228	41	-22.1113	119.2472	28/4/17	29/8/17	123
Mesa 228	42	-22.1121	119.2465	28/4/17	29/8/17	123
Mesa 228	43	-22.1131	119.2463	28/4/17	29/8/17	123
Mesa 228	45	-22.1175	119.2455	28/4/17	29/8/17	123
Mesa 228	46	-22.117	119.2454	28/4/17	29/8/17	123
Mesa 228	47	-22.1163	119.2454	28/4/17	29/8/17	123
Mesa 228	48	-22.1156	119.2456	28/4/17	29/8/17	123
Mesa 228	49	-22.1151	119.2457	28/4/17	29/8/17	123
Wall creek	Wc50	-22.0299	118.6268	30/4/17	9/8/17	101
Wall creek	Wc52	-22.0291	118.6268	30/4/17	9/8/17	101
Wall creek	Wc53	-22.0282	118.6269	30/4/17	9/8/17	101
Wall creek	Wc54	-22.0275	118.6277	30/4/17	9/8/17	101
Wall creek	Wc55	-22.0275	118.6287	30/4/17	9/8/17	101
Wall creek	Wc56	-22.0272	118.6296	30/4/17	9/8/17	101
Wall creek	Wc57	-22.0265	118.6302	30/4/17	9/8/17	101
Wall creek	Wc58	-22.0257	118.6297	30/4/17	9/8/17	101
Wall creek	Wc59	-22.0253	118.629	30/4/17	9/8/17	101
Wall creek	Wc60	-22.0245	118.6284	30/4/17	9/8/17	101

Table 7. Locations of individual trap sites in the targeted northern quoll trapping survey at Quoll Knoll, locations are given in decimal degrees.

Name	Latitude	Longitude	Elevation (m)	Start date	End date
QK10	-22.09839	119.2363	395	28/04/2017	2/05/2017
Qk091	-22.09822	119.2362	401	28/04/2017	2/05/2017
Qk081	-22.09807	119.2364	399	28/04/2017	2/05/2017
Qk071	-22.09763	119.2365	394	28/04/2017	2/05/2017
Qk061	-22.09744	119.2366	391	28/04/2017	2/05/2017
Qk011	-22.09677	119.2372	404	28/04/2017	2/05/2017
Qk021	-22.09656	119.2371	404	28/04/2017	2/05/2017
Qk051	-22.09650	119.2369	404	28/04/2017	2/05/2017
Qk041	-22.09641	119.2369	406	28/04/2017	2/05/2017
Qk031	-22.09633	119.2370	407	28/04/2017	2/05/2017

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