Fortescue Marsh Feral Cat Baiting Program
(Christmas Creek Water Management Scheme)
Year 2
Annual Report

November 2013

Department of Parks and Wildlife

Prepared by

Cameron Tiller[1], Peter Speldewinde[2], Saul Cowen[3], Lucy Clausen[3], Louisa Bell[3], Jeff Pinder[3], Jon Pridham[3], Sarah Comer[3] and Dave Algar[4]

[1]Environmental Consultant
Victoria
camtiller@y7mail.com

[2]Assistant Professor
Centre of Excellence in Natural Resource Management
University of Western Australia-Albany
PO Box 5771, Albany, WA
peter.speldewinde@uwa.edu.au

[3]Integrated Fauna Recovery Team,
South Coast Region, Department of Parks and Wildlife
120 Albany Highway, Albany WA
sarah.comer@dpaw.wa.gov.au

[4]Senior Research Scientist, Fauna Conservation
Science and Conservation Division, Department of Parks and Wildlife
PO Box 51, Wanneroo, WA 6946
dave.algar@dpaw.wa.gov.au

Department of
Parks and Wildlife

Contents

Figures

Tables

Appendices

Executive Summary Year 1 and 2 (2012-2013)

The Department of Parks and Wildlife (DPaW) is implementing Fortescue Metals Group's (FMG) Fortescue Marsh Baiting Plan (FMG, 2011) to satisfy Condition 16 of the EPBC Act approval 2010/5706, which is aimed at improving protection and long-term conservation of EPBC Act listed species in the Fortescue Marsh. The baiting program is meeting specific targets for FMG (loc. cit) which include:

a) Comprehensive landscape scale feral cat baiting program (across a minimum 150,000ha) on the area proposed as conservation estate on the Fortescue Marsh
b) A baiting program developed with expert advice , defining intensity and frequency of baiting in order to maximise the benefits of removal of feral cats to EPBC Act listed threatened and migratory species
c) Monitoring of feral cat populations and EPBC Act listed threatened and migratory species.

Landscape scale baiting of feral cats is still in an experimental phase (this project covered under Experimental Permit issued by the Australian Pesticides and Veterinary Medicines Authority No. PER12732). The delivery of this project was designed in an adaptive management framework, and with consideration of similar projects managed by DPaW elsewhere in Western Australia in order to maximise learning outcomes.

The baiting program commenced in 2012 with a total area of 838 km^2 baited with the feral cat bait *Eradicat®*. Baiting was conducted in mid-winter to maximise uptake of baits by feral cats, and followed a pre-bait survey for cats. Two measures of baiting efficacy were proposed: (1) direct knockdown of radio-collared cats and (2) changes in the occupancy of feral cats pre- and post-baiting based on remote camera detection. Occupancy modelling addresses the inherent difficulties in estimating abundances of cryptic, secretive, far ranging carnivore species that occur in low abundances. Occupancy is often used as a metric for estimating occurrence for various species and is a function of abundance as it concerns the probability of a particular animal being at a given site, in this case a camera trap. In addition, occupancy surveys require lower sample sizes than abundance surveys. In 2012 late delivery of funds resulted in pre-bait radio collaring of feral cats being limited to a single animal. As a result the remote cameras, which were established in control and treatment sites over an area of one million hectares, were the only measure available to determine bait uptake in 2012. Some 2,767 camera-nights were recorded in 2012 and 4660 camera nights in 2013. A significant decline in probability of occupancy by feral cats in the treatment site was observed post-baiting for both years of baiting (Tiller *et al*., 2012; Tiller *et. al.,* 2013).

In 2013 investigation of feral cat habitat use and movement patterns were conducted utilizing GPS radio-collars attached to nine feral cats. Occupancy modelling employing detection histories was used to generate a probability of occupancy of a site from data provided by remote camera-trap surveys to determine the efficacy of baiting.

The 2013 study also included bird surveys using distance sampling and use of Autonomous Recording Units (ARUs) to provide baseline data to help clarify the impact that feral cat control can have on populations of native species.

Two of the nine radio-collars attached to feral cats could not be re-located, resulting in data retrieved from seven collars. Of these, two collars dropped off prematurely due to a manufacturing issue. Two cats were deceased when located, although data from these cats suggests that they died prior to the bait application but the carcasses were too dehydrated to determine cause of mortality. Staff also located a deceased non-collared feral cat within the baited area. The appearance of this animal was similar to one identified on a remote camera prior to bait delivery and the state of decay of the carcass suggests that it was likely to have succumbed to a bait/baits.

In 2012 the project team also evaluated the Fortescue Marsh study area for EPBC listed species. Surveys were conducted for suitable Northern Quoll habitat, and none was identified in the Marsh. Greater Bilby signs were observed by the team when establishing camera trapping sites, and a single animal detected on remote cameras. Bilby sign is uncommon in the marsh, and monitoring of areas of activity will be increased in future years. Crested-tailed Mulgara habitat occurs throughout the baiting area, although no animals have been detected on cameras and previous surveys have only found this species in small areas which are not the subject of the feral cat baiting cell. Other EPBC Act species recorded on the Marsh include the Night Parrot, which has not be recorded at Fortescue Marsh since 2006 (Davis & Metcalf, 2008) and the Fork-tailed Swift, which is a summer migrant to Australia and is unlikely to be present during the survey period. Only one species, the Rainbow Bee-eater, has been recorded during surveys in 2012 and 2013 and due to its ecology and behaviour (arboreal, aerial forager) only likely to be recorded from sightings and possibly ARUs.

2013 Summary

The *Eradicat*® feral cat bait has been developed for application in areas where native fauna have a high tolerance to 1080 (sodium fluoroacetate). This bait is currently in the process of registration with the Australian Pesticides and Veterinary Medicines Authority for general use in the management of feral cat populations in conservation areas. To assist the process of registration, trials such as the feral cat management program at Fortescue Marsh are providing essential feedback into the success and application techniques of this introduced predator management tool.

Eradicat® baits were aerially distributed to 850km^2 within and immediately surrounding the Fortescue Marsh, Pilbara region, Western Australia. This trial is part of a series of field trials conducted throughout different habitats and climatic zones across Western Australia and off-shore islands.

Currently, there is no ideal method of monitoring feral cat abundance or activity. However, the Fortescue Marsh feral cat management program is assisting the development of a monitoring method utilising remote camera-trapping with the intention of site occupancy modelling to determine changes that will enable an assessment of the efficacy of the baiting program.

Investigation of feral cat habitat use and movement patterns were conducted utilizing GPS radio-collars attached to nine feral cats. Occupancy modelling employing detection histories was used to generate a probability of occupancy of a site from data provided by remote camera-trap surveys to determine the efficacy of baiting. The 2013 study also included bird surveys using distance sampling and use of Autonomous Recording Units (ARUs) to provide baseline data to help clarify the impact that feral cat control can have on populations of native species.

Two of the nine radio-collars attached to feral cats could not be re-located resulting in data retrieved from seven collars. Of these, two collars dropped off prematurely due to a manufacturing issue. Two cats were deceased when located, although data from these cats suggests that they died prior to the bait application but the carcasses were too dehydrated to determine cause of mortality. Staff also located a deceased non-collared feral cat within the baited area. The appearance of this animal was similar to one identified on a remote camera prior to bait delivery and the state of decay of the carcass suggests that it was likely to have succumbed to a bait/baits.

Analysis of the site occupancy modelling showed that there was a significant reduction in feral cat site occupancy in the treatment cells after baiting.

Problems encountered during the 2013 study included:

- An error in loading the navigation cells resulted in the aerial bait drop occurring in the previous year’s bait cell. This resulted in many of the newly established monitoring sites falling outside the boundary of the baited area.
- Manufacturing problems were identified with some of the GPS radio collars that were used in this study. These issues resulted in several collars falling off

the animals prematurely. Other collars ceased data collection for no apparent reason. These issues are being followed up with the manufacturers of this product.

1 Background

1.1 Introduction

The Australian arid zone has experienced a high rate of native mammal decline following European settlement. Since the 1920s, approximately 33% of all mammals and about 90% of medium-sized mammals (35-5500g adult bodyweight range) have either suffered dramatic range contractions or are extinct (Burbidge & McKenzie 1989). Many of these species are now restricted to several offshore islands and others, due to small population sizes and restricted geographic ranges, are vulnerable to total extinction. A number of causes have been proposed to explain this decline. These causes include changed fire regimes, competition from introduced herbivores, disease, extreme variability in weather and site fertility and predation by introduced predators, specifically the feral cat (*Felis catus*) and the European red fox (*Vulpes vulpes*) (see Abbott 2002; Burbidge & McKenzie 1989; Dickman 1996a, b; EA. 1999; Johnson *et al*. 1989; Morton 1990).

Feral cats are defined as cats that live and reproduce in the wild and survive by hunting or scavenging (DEWHA 2008a). Predation by feral cats has been demonstrated to threaten the continued survival of many native species persisting at low population densities (e.g. Risbey *et al*. 2000; Smith & Quin 1996) and has been identified as one of the major obstacles to the reconstruction of faunal communities as it has prevented the successful re-introduction of a number of species to parts of their former range (Christensen & Burrows 1995; Dickman 1996b; EA. 1999; Gibson *et al*. 1995). The suppression of introduced predators is therefore a critical component of successful reintroduction, recovery or maintenance of populations of small to medium-sized native fauna (Christensen & Burrows 1995; Fischer & Lindenmayer 2000; McKenzie *et al*. 2007).

Effective control of feral cats over large areas is recognised as one of the most important fauna conservation issues in Australia today and as a result, a national Threat Abatement Plan (TAP) for Predation by Feral Cats (DEWHA 2008a; EA 1999) has been developed. The objective of the TAP is to protect affected native species and ecological communities, and to prevent further species and ecological communities from becoming threatened. The impact of feral cats in the Pilbara is discussed in McKenzie *et al*. (2009), and addressing this threat will have a significant impact on maintaining populations of native species in this area. Furthermore for waterbirds, cat control on Fortescue Marsh is highly desirable, given this site is designated as a Wetland of National Importance (Directory of Important Wetlands in Australia, (EA2001). It is also proposed for nomination as a Ramsar site.

The management of feral cat populations in Australia is currently limited by the lack of a cost-effective control technique. The effectiveness of existing techniques, including trapping, shooting and fencing, are limited by a significant input cost when implemented over large areas. Baiting is recognized as the most effective method for controlling feral cats on mainland Australia (Algar & Burrows 2004; Algar *et al*. 2007; DEWHA 2008a; EA 1999; Short *et al*. 1997), when there is limited risk posed to non-target species. The feral cat bait (*Eradicat*®) (detailed description in Algar & Burrows (2004) Algar *et al*. (2007) has proven to be an effective tool in reducing feral cat numbers. Most baiting campaigns have shown that baiting for feral cats can consistently achieve highly effective control, especially in semi-arid and arid areas. When the results of broad-scale baiting have been less successful, it can generally be attributable to unfavourable weather conditions at the time of baiting or an abundance of prey (Algar *et al*., in press).

The Fortescue Marsh baiting program will maximise the benefits of the control of feral cats while minimising the risk to migratory and EPBC Act listed species.

1.2 Site description

The Fortescue Marsh is an extensive intermittent wetland situated at 22^{0} 26’ 44” S, 119^{0} 26’ 38” E, in the Pilbara region of Western Australia. It is located in the Pilbara Craton (Hamersley Basin) and has the form of a broad valley or small plain that lies between the Chichester and Hamersley Ranges. The Marsh occupies an area of approximately 1,000km^2 when in flood (DEWHA 2008b) (Figure 1).

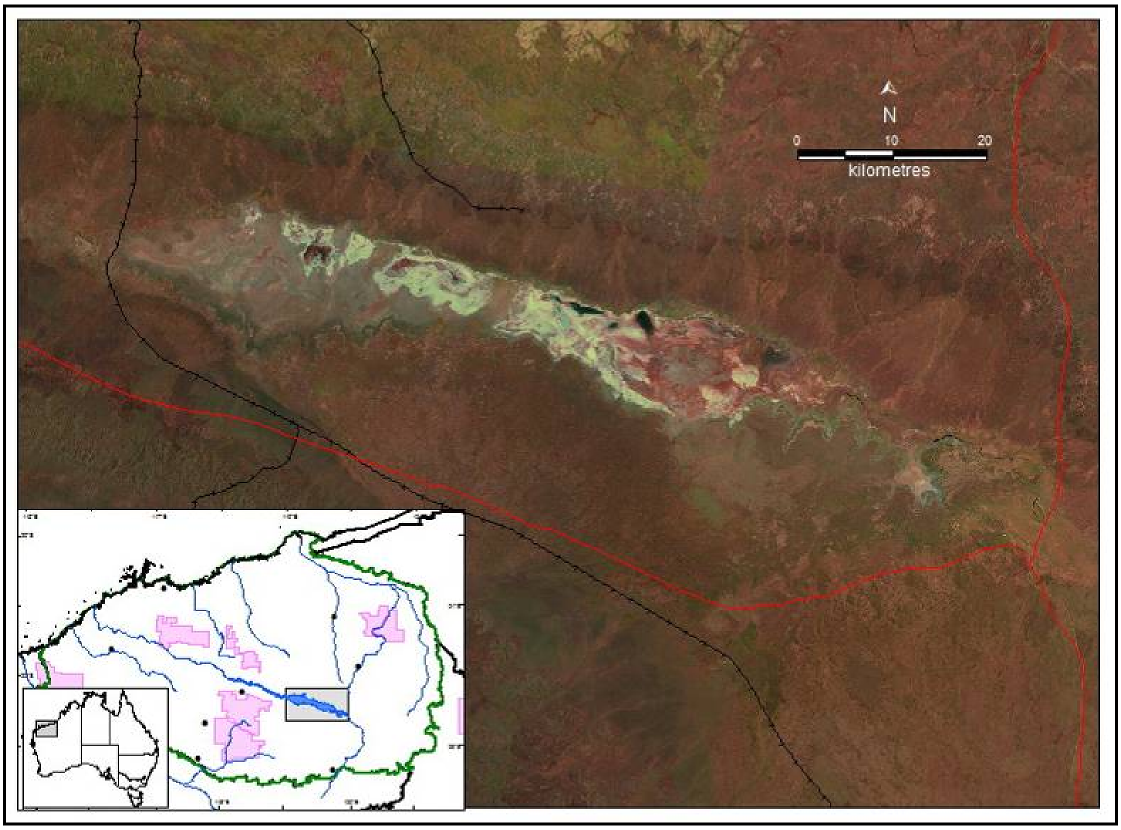


Figure 1. Location and regional setting of the Fortescue Marsh

McKenzie *et al*. (2009) provide a succinct summary of the vegetation, climate and physiographic environment of the Pilbara as it relates to the biota. Climatic conditions in the Pilbara are influenced by tropical cyclone systems that predominately occur between January and March. The majority of rainfall received in the Pilbara is associated with these systems. The longterm average annual rainfall is 312mm at

Newman (Fortescue 2009). Temperatures are high, with summer maxima typically 35-40 °C and winter maxima 22-30 °C.

Botanical surveys conducted for Fortescue Metals Group's (FMG) Cloud Break Iron Ore Project Public Environmental Review included fringing vegetation of the Marsh. Five distinct vegetation communities identified by Mattiske Consulting Services (2005), (cited in Fortescue 2009), have been used to describe the vegetation at each monitoring site. These include the following vegetation descriptions:

1. low woodland to low open forest of *Acacia aneura*, *A*. *citrinoviridis*, *A*. *pruinocarpa* over *A*. *tetragonophylla* and *Psydrax latifolia* over *Chrysopogon fallax*, *Stemodia viscosa*, *Blumea tenella*, *Themeda triandra* and species of *Triodia* and *Aristida*. This vegetation community occurs within the creek and drainage lines leading into the Marsh;
2. hummock grassland of *Triodia angusta* with patches of *Acacia victoriae*, *A*. *aneura*, *A*. *xiphophylla* over *Atriplex codonocarpa*, *Eremophila cuneifolia* and mixed chenopods;
3. low halophytic shrubland of *Tecticornia auriculata* and *T. indica* with associated chenopods including *Maireana* species and *Atriplex flabelliformis* with *Muehlenbeckia florulenta* with patches of *Acacia victoriae* and *A*. *sclerosperma*. This vegetation community adjoins the low woodland to low open forest of *A. aneura*;
4. low halophytic shrubland of *T. auriculata*, *T*. *indica*, *T*. *halocnemoides* with patches of *Frankenia* species. This is the predominant vegetation community along the fringes of the Marsh and
5. hummock grassland of *Triodia angusta* with patches of *Acacia victoriae* over *A. codonocarpa* and mixed chenopods and Poaceae species.

1.3 Unintentional change to bait cell

An operational error in loading the correct navigation file resulted in the planned 2013 bait cell reverting back to the bait cell used in 2012 at the site of the Fortescue Marsh feral cat management project. As a result, a number of the camera-trap monitoring sites were now located in an unbaited area and the feral cats that were collared were actually animals occupying territories outside of the bait zone. This error reduced the power of analysis of baiting efficacy but with 29 camera-traps still located within the bait zone, there were still sufficient camera data to ascertain baiting efficacy with a relatively high degree of confidence. The placement of camera-trap survey sites, now outside the bait zone, provided an important opportunity to study the distribution and habitat use of feral cats within different habitats across the entire marsh as the lack of late seasonal rainfall enabled access to areas that were waterlogged during the 2012 field season. GPS data from the collared feral cats also provided important insight into the habitat use of feral cats within habitats immediately adjacent to the marsh and the Cloudbreak mine footprint. The targeted bird surveys will also provide important baseline data in areas affected by the feral cat management project.

1.4 2013 Objectives

The primary aim of the Fortescue Marsh feral cat baiting program is to undertake trials over a five-year period to establish an efficient and cost-effective method of controlling feral cats at a semi-arid mainland site, minimising risk of baiting and maximising the survival of populations of native species.

1. Trap 10 feral cats in habitat immediately adjacent to the baited cell to monitor their habitat use and movement patterns using GPS radio collars.
2. Conduct an early winter aerial application of *Eradicat*® baits at a rate of 50 baits/km^2.
3. Monitor the resident feral cat population pre- and post-baiting to determine rate of survival using detection histories from remote camera data for site occupancy modelling.
4. Conduct targeted bird surveys to determine the extent and distribution of species throughout the study sites, including distance sampling and Autonomous Recording Units (ARUs).
5. Commence trapping for feral cats from around mine-related infrastructure for analysis of preferred prey items from stomach contents and tissue sampling for future genetic studies.

2 Methods

2.1 2013 Project timing

Delays to the commencement of the monitoring program during 2012 resulted in the timing of the project to be pushed back to the limit for acceptable baiting (ie. late winter). This caused baiting to occur during the period when temperatures and, hence, the activity of native mammals and reptiles (prey species of the feral cat) increased. This would likely decrease the duration of palatability of baits for feral cats (due to drying), and increase the vulnerability of non-target species whilst decreasing the availability of baits due to uptake of baits by native species. For 2013, the timing of baiting was brought forward to 25 June to negate these influences.

The 2013 field monitoring program was conducted 22 April - 30 August (Table 1).

Table 1. Project field timetable – 2013

Date	Activity	Achievement
22 April – 10 May	Setup sites	– 64 camera survey sites established as proposed Baited cell – 31 camera survey sites established as Control cell
14 – 31 May	– Feral cat trapping – Set up lures and turn on cameras	– 9 cats captured and collared in nine days (706 trap-nights) – 95 cameras attended to pre-baiting
15 – 23 June	Cameras turned off and lures removed	95 camera sites attended to
25 June	*Eradicat*® baits distributed by fixed wing aircraft	85,000 hectares baited
15 – 22 July	Camera sites re-instated	95 camera sites attended to post- baiting
14 – 30 August	– Collect feral cat radio-collars – Pack up cameras – Feral cat trapping around Christmas Creek and Cloudbreak camp areas	– 7 out of 9 collars located – 95 (all) cameras and lures retrieved – 6 feral cats captured and euthanized (602 trap-nights) DNA and stomach samples collected

2.2 Study area

2.2.1 Treatment area/bait cell 2013

The treatment site was located on the eastern side of the study area, where the Marsh is at its widest (Figures 2 & 3). Due to the baiting error (see Section 1.3), this site was identical to the area baited in the first year of the program which enabled a comparison between early and late winter baiting. This baited area comprised land from the Marillana, Mulga Downs, Hillside and Roy Hill pastoral leases (Table 2, Figure 4). At the previous request from station managers, a buffer zone of 1 km for both baiting and monitoring activities was provided around active bores and wells within the baited cell.

Due to dryer conditions, the area that was underwater during May 2012 (see water boundary, Figure 2) was accessible during field surveys in 2013. This enabled camera-traps to be established to determine the level of activity and occupancy of feral cats in these areas of the marsh. Knowledge of the level of feral cat use of this habitat will help to determine the most appropriate location for the most effective feral cat control in the future.

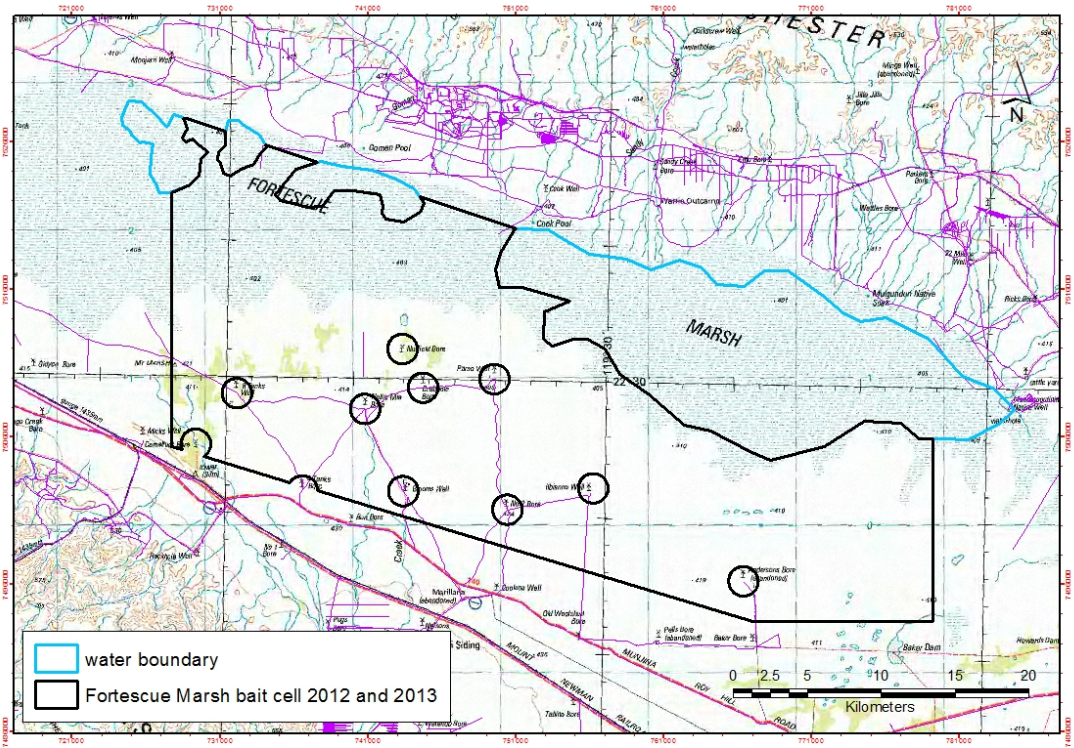


Figure 2. Location of the 2012 and 2013 bait cell at Fortescue Marsh

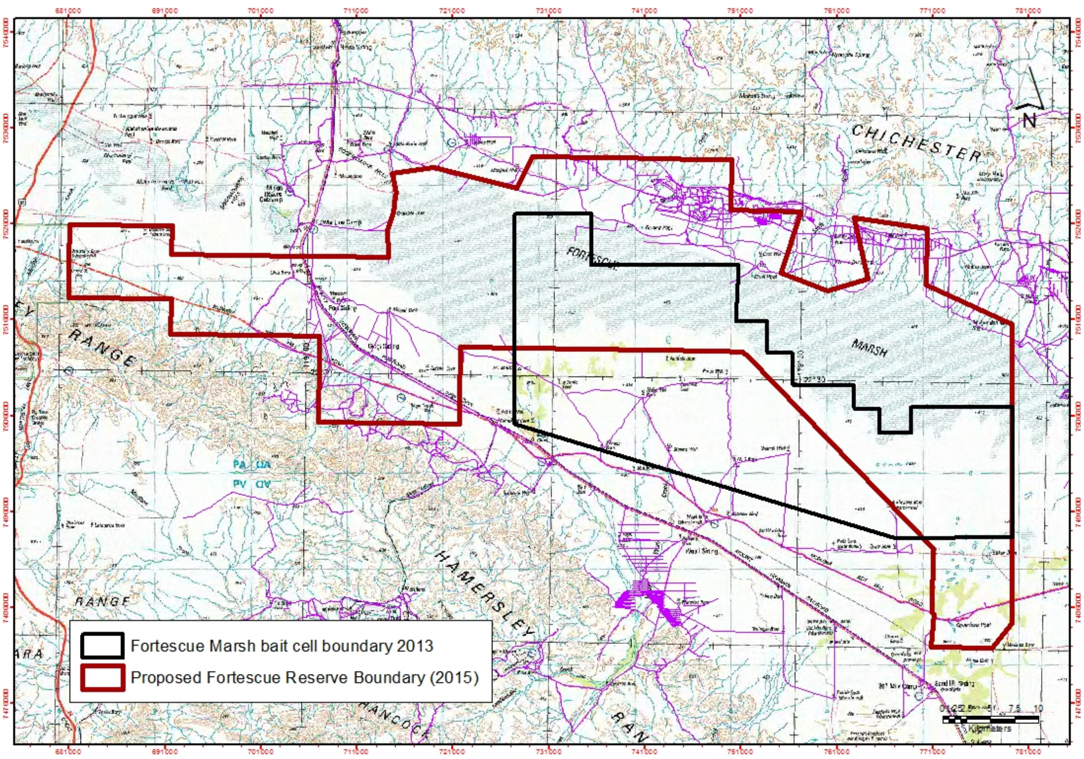


Figure 3. Location of bait cell and boundary of land to be relinquished from pastoral lease in 2015 at Fortescue Marsh

Table 2. Location and size of bait cell within each pastoral lease and the boundary of DPaW managed land at the Fortescue Marsh

Pastoral lease /DPaW managed land	Bait cell (km^2)	% Pastoral lease / DPaW managed land in bait cell
Marillana	671.5	18.8
Roy Hill	194.9	4.9
Hillside	242.7	6.0
Mulga Downs	131.2	3.7
DPaW managed land in 2015	838.9	46.6

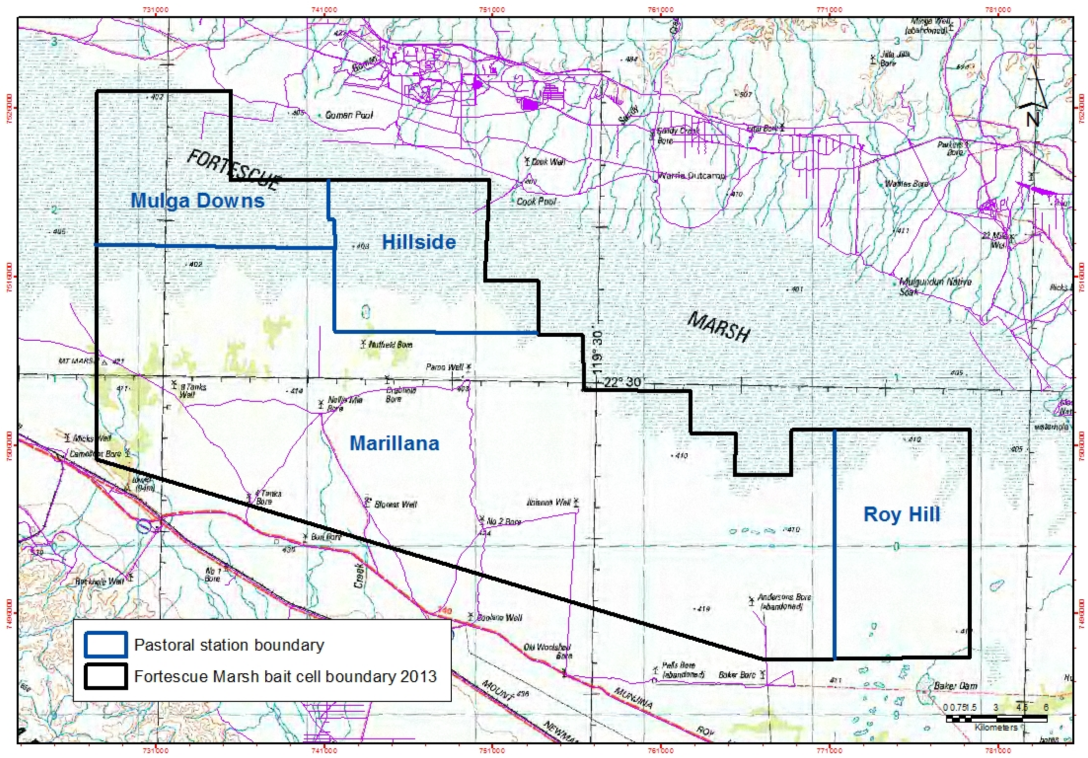


Figure 4. Location of pastoral lease boundaries within the baited cell at Fortescue Marsh, 2013

2.2.2 Control area 2013

The original control area (Control 1) was located immediately west of the treatment site, within the Hillside, Mulga Downs and Marillana pastoral leases (Figure 5). The extent of the 2013 control area was reduced from that used in 2012 to reduce the effect of human disturbance at monitoring sites and maintain comparable habitat to sites within the treatment area. The BHPRIO railway was used as the western boundary of the control area.

To ensure independence between the treatment and control sites, a buffer of a minimum 5 km was used to separate monitoring sites. This distance is estimated to be at least one average feral cat home range (D. Algar unpub. data).

The area immediately north of the baited cell and including control site 2 (Figure 5) was a new area monitored by camera-traps in 2013. This was to take advantage of an opportunity to cover all habitats within the marsh - in usual conditions, this area is inaccessible due to waterlogging. This area between the baited cell and Control 2 is referred to in the report as "Buffer".

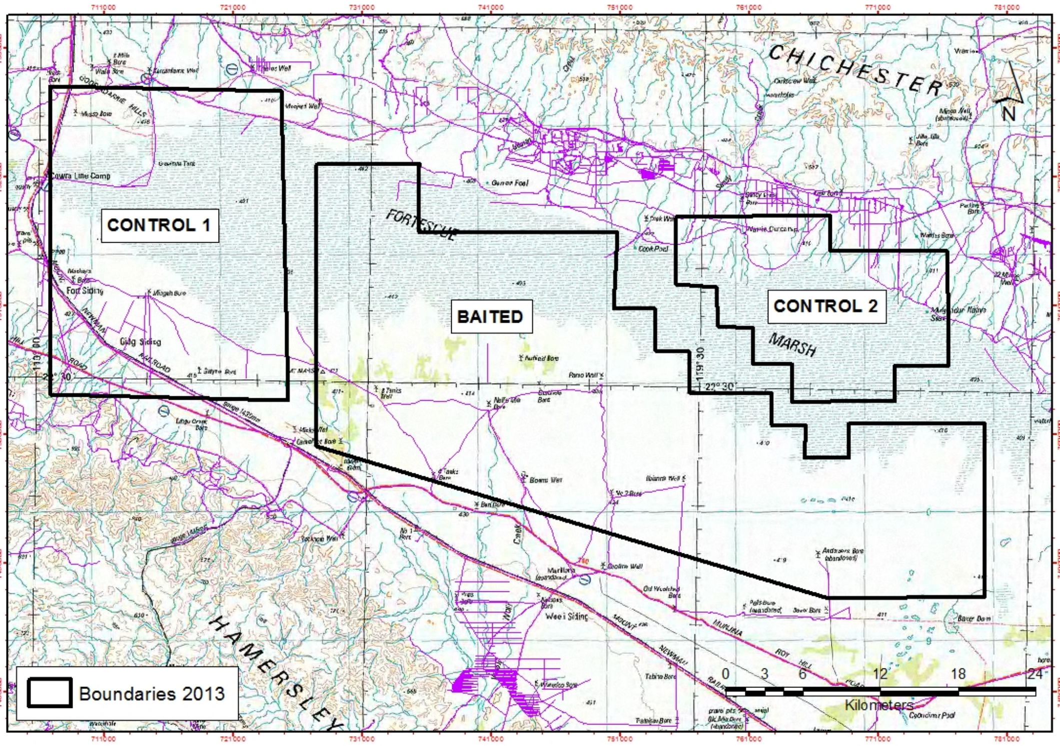


Figure 5. Location of treatment and control site boundaries at the Fortescue Marsh, 2013

2.3 Weather

Rainfall data from Cloudbreak was only available for the pre-baiting period. Given the significance of rainfall post baiting data from Newman has been used to illustrate the general conditions in the study area over the baiting program.

Table 3. Rainfall data from Newman Aerodrome for the field survey period April – August 2013 (Bureau of Meteorology 2013)

	Apr	May	Jun	Jul	Aug
1st	0	0	0	0	0
2nd	0	0	0	0	0
3rd	0	0	16.8	0	0
4th	0	0	3.8	0	0
5th	0	0	2.2	0	0

6th	0	0	1	0	0
7th	0	0	0	0	0
8th	0.4	0	0	0	0
9th	0	0.2	0	0	0
10th	0	0	0	0	0
11th	0	0	0	0.2	0
12th	0	0	1.4	9.4	0
13th	0	0	0	0	0
14th	0	0	0	0	0
15th	0	9	0	0	0
16th	0	0.2	0	0	0
17th	0	0	0	0	0
18th	0	0	1.4	0	0
19th	0	0	2	0	0
20th	0	1.2	0	0	0
21st	0	0	0	0	0
22nd	0	0	0	0	0
23rd	0	0	0	0	0
24th	0	0	2.8	0	0
25th	0	0	37.4	0	0
26th	0	0	0.2	0	0
27th	2	0	0	0	0
28th	0	0	0	0	0
29th	0	0	0	0	0
30th	0	0	0	0	0
31st		0		0	0
Highest (mm)	2	9	37.4	9.4	0
Monthly (mm)	2.4	10.6	69	9.6	0

2.4 Baits and baiting

The feral cat baits (*Eradicat*®) used in the Fortescue Marsh baiting program are manufactured at DPaW's Bait Manufacturing Facility at Harvey, Western Australia. The bait is similar to a chipolata sausage in appearance, approximately 20g wet-weight, dried to 15g, blanched and then frozen. This bait is composed of 70% kangaroo meat mince, 20% chicken fat and 10% digest and flavour enhancers (Patent No. AU 781829). Toxic feral cat baits are dosed at 4.5 mg of sodium fluoroacetate (compound 1080) per bait. All feral cat baits are sprayed during the sweating process with an ant deterrent compound (Coopex®) at a concentration of 12.5g l^{-1} as per the manufacturer's instructions. This process is aimed at preventing bait degradation by ant attack and enhancing acceptance of baits by cats by limiting the physical presence of ants on and around the bait medium.

Baiting operations were conducted under an 'Experimental Permit' (Permit No. PER14102ver2) issued by the Australian Pesticides and Veterinary Medicines Authority and governed by the 'Code of Practice on the Use and Management of

1080’ (Health Department, Western Australia) and associated ‘1080 Baiting Risk Assessment’.

Frozen baits were transported to the Auski airstrip in the dedicated Western Shield bait truck. On the morning of 25 June, 43,000 were arranged on established bait racks at the Auski airstrip such that they were in direct sunlight to thaw and ‘sweat’. This process causes the oils and lipid-soluble digest material to exude from the surface of the bait making the bait more attractive to feral cats. A Beechcraft Baron B58 twin-engine aircraft (Thunderbird Aero Service, Western Australia) fitted with computerised, GPS-linked equipment was used to deploy the baits to ensure accurate application. During 2012, a series of panel lights indicated to the bombardier when to release the baits, with a GPS-linked mechanism used to prevent the application of baits outside the programmed bait cell. The location of the aircraft was logged each time baits were released. Trials to increase the spread of baits during late 2012 (D. Algar unpub. data) resulted in the implementation of a ‘carousel’ to assist the bombardier during the 2013 baiting at Fortescue Marsh. This allowed baits to be released in four drops over a kilometre instead of baits being clumped on the ground as was found in the previous year. Bait distribution is now in a 200m long 40m wide swathe, increasing the potential for feral cats to encounter a viable bait.

The aircraft operated at approximately 160 knots at a height of 500ft, flying east-west transects across the Fortescue Marsh bait cell. Figure 6 displays the location of the plane for each bait drop.

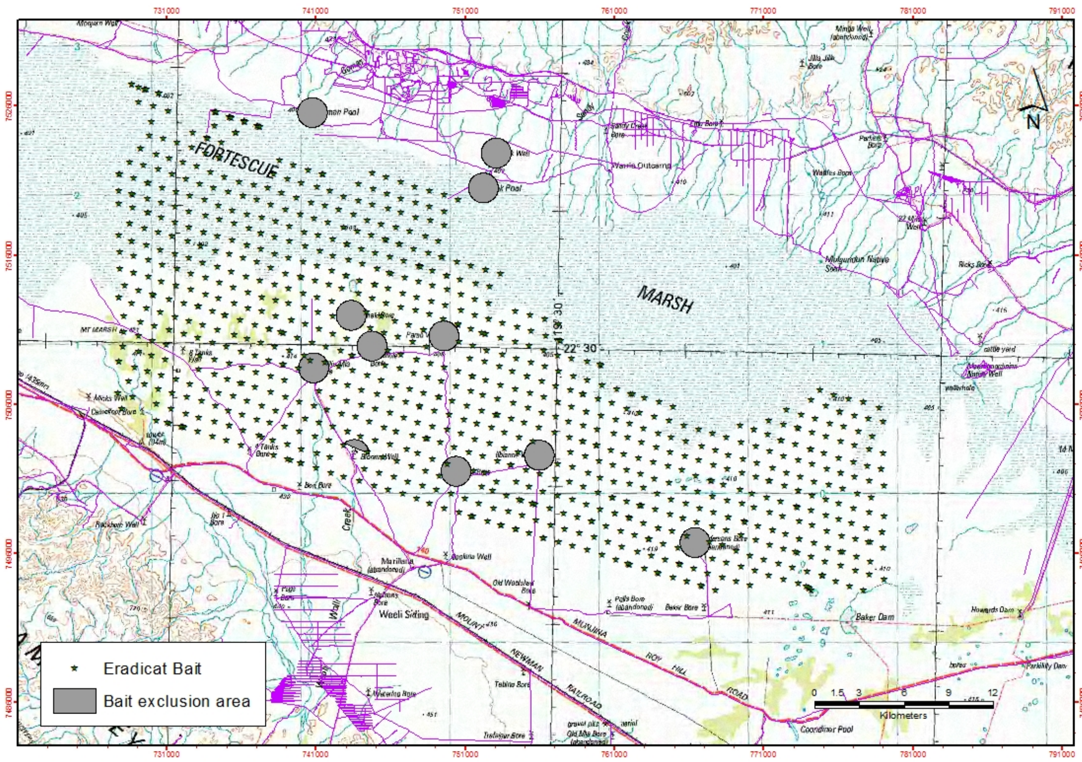


Figure 6. Location of bait drops in Fortescue Marsh (2013) with bait exclusion zones included

2.5 Feral cat monitoring and control

Two independent methods for monitoring baiting efficacy were implemented: 1) trap, radio-collar and release of feral cats prior to the baiting program; and 2) detection of site occupancy using camera-trap surveys of feral cat activity. The proportion of collared feral cats killed, i.e. direct mortality, and the difference in the indices of pre- and post-bait site occupancy (determined by activity at camera-trap monitoring sites) are used as a measure of baiting efficacy.

Genetic analysis can assist with identifying the relationship of animals located in areas with significant infrastructure to the feral cat population within the marsh. Although beyond the scope of the 2013 program, samples were (and will continue to be) collected annually and analysed in the final year of the program.

In addition to baiting, feral cat control across the landscape is optimised by utilising a number of different techniques. Feral cats located around human infrastructure (i.e. Cloudbreak and Christmas Creek camp areas) were controlled by a targeted trapping program in August (post baiting). Stomach samples were collected to investigate the diet of these individuals.

2.5.1 Feral cat trapping and GPS radio-telemetry

The cat trapping program at Fortescue Marsh was due to commence on 18 May but was delayed because of the forecast of 10-20mm (90% probability) for 19 May. A total of 21mm rainfall was recorded at Cloudbreak for 19 May. This amount of rainfall and subsequent run-off into the Marsh prevented access to the site until 21 May when trap placement commenced. All traps were retrieved on 29 May when a fall of a further 13mm of rain occurred, that would have prevented any further trapping for a number of days.

The trapping technique involved the use of padded leg-hold traps Victor 'Soft Catch'® traps No. 3 (Woodstream Corp., Lititz, Pa.; U.S.A.) with a mixture of cat faeces/urine (pongo) and an audio lure (Felid Attracting Phonic, (FAP), Westcare Industries, Bassendean, Western Australia) as the attractants. Trap sets were parallel to the track along the verge every 0.5km. Traps set at the 1.0km intervals used both the FAP and pongo lure combination while trap sets at 0.5km intervals employed the pongo lure alone. Open-ended trap sets were employed with two traps positioned lengthwise (adjoining springs touching) and vegetation/sticks used as a barrier along the trap sides. The location of the trap sets and feral cat captures are indicated in Figure 7 and the dates of commissioning and decommissioning traps are provided in Table 4.

Table 4. Dates of commissioning and decommissioning traps

No. traps	Commissioned	Decommissioned	No. trap nights
29	21/5/2013	30/5/2013	261
32	22/5/2013	30/5/2013	256
27	23/5/2013	30/5/2013	189

TOTAL	**706**

Trapped cats were sedated with an intramuscular injection of 4mg/kg Zoletil 100® (Virbac, Milperra; Australia). All animals captured were sexed and weighed and coat colour recorded; a broad estimation of age (as either kitten, juvenile or adult) was registered using weight as a proxy for age. Hair and an ear notch were taken for potential DNA analysis at a later date. A GPS data-logger/radio-telemetry collar with mortality signal (Telemetry Solutions, California, United States) was fitted. The collars were factory programmed to take a location fix every 60 minutes. All cats were released at the site of capture.

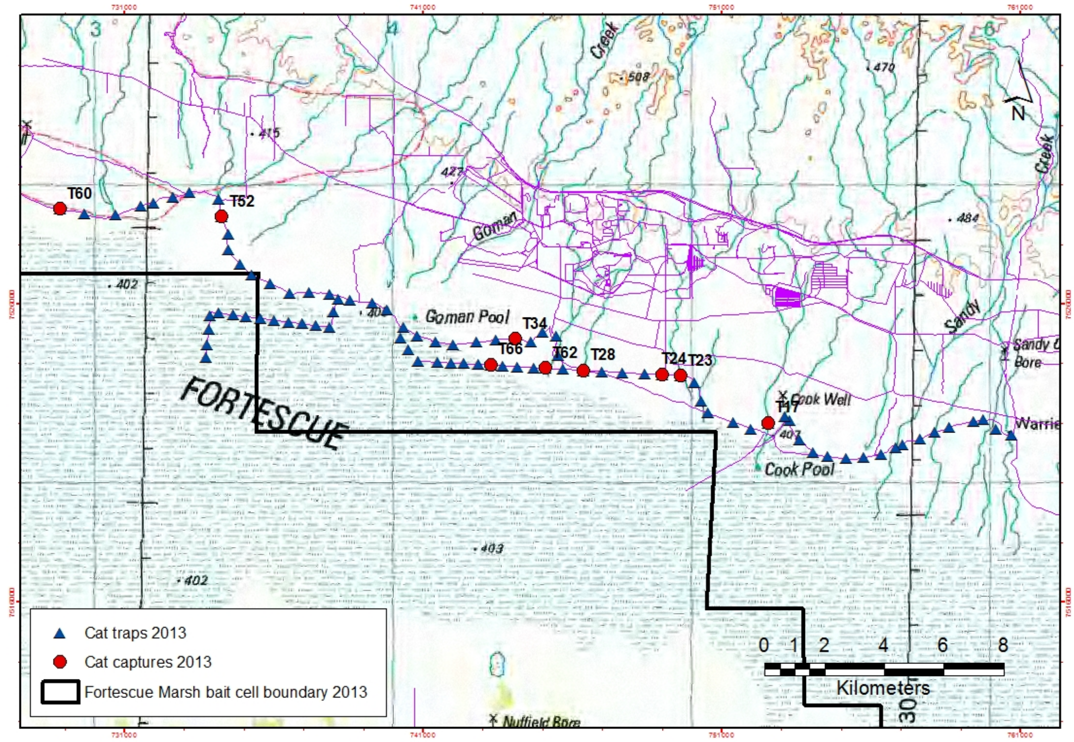


Figure 7. Location of traps and feral cat captures at the Fortescue Marsh in 2013

2.5.2 Monitoring and recovery of radio-collared cats

The approximate location and status of cats (alive or dead) was determined by use of radio-telemetry techniques. Four collars were fitted with a drop-off mechanism to assist the recovery of the collar. To retrieve the other collars, methods such as tracking to shoot the animal were employed. The pulse rate of the Telemetry Solutions collars doubled if the collar had remained motionless for ten hours, that is, if the cat was dead or the collar had dropped off. The data was filtered to remove points from the day of collar attachment (to remove bias caused by the stress of capture and anaesthetic), points after the day the collar was recorded motionless, and all points where the collar failed to collect a location (e.g. cat in sheltered den site).

Home range sizes were calculated using minimum convex polygon (MCP) 95% and 100%. That is, creating a polygon by connecting the most outer data points. The MCP100 which uses all data points to calculate home range is sensitive to sample size and outliers. To combat the issue of sample size, only samples with a minimum of three weeks data (i.e. 504 data points) are used. To minimise the impact of outliers on home range estimates, MCP95 is also provided which reduces the sample by removing the 5% of data points furthest from the sample mean.

A Robinson 44 helicopter (All North Helicopters) was used to locate all operational collars on 16 August 2013, a total of 53 days after baits were deployed, to provide feedback on the effectiveness of baiting. Following detection of motionless collars, staff accessed each site to recover GPS collars. Feral cats with collars that did not automatically drop off and were not affected by baiting were targeted by hunting on 16 August 2013.

2.5.3 Feral cat - site occupancy using automated cameras

Detection of a species at a site confirms that the species is present at the site, but, non-detection at the site does not necessarily mean that the species is absent (MacKenzie et al. 2006, Boitani and Powell, 2012). An occupancy model using detection histories at camera sites across the Marsh was used to generate a probability of a particular site being occupied by a feral cat rather than just presence/absence. To determine the impact of the baiting program the camera grid was operating in both treatment and control sites.

In 2013 site occupancy was determined using a Bayesian occupancy model with modelled random effects. Bayesian modelling was chosen for occupancy modelling in 2013 rather than conventional techniques (such as presence) as Bayesian techniques offer the potential to model spatial autocorrelation. One of the assumptions of occupancy modelling is that an individual will not appear on more than one camera. Being able to model the spatial autocorrelation will minimise the impacts of individuals appearing on multiple cameras. Spatial autocorrelation model is still being developed. Models were run with a burn in of 5000 iterations before sampling for 5000 iterations. Models were run pre and post baiting. An occupancy model using detection histories at camera sites across the Marsh was used to generate a probability of a site being occupied by a feral cat rather than just presence/absence data. The statistical power of the model was improved by operating the camera grid in both treatment and control sites. The probability of detection is based on meeting four assumptions as detailed in MacKenzie et al. (2006): population closure, no un-modelled heterogeneity in occupancy, no un-modelled heterogeneity in detection, and detection histories at each site are independent. In the first year of the Fortescue Marsh feral cat baiting program, the focus was primarily on developing the appropriate methodology for the application of these robust techniques to camera-trapping data (Tiller et al., 2012). The second year of the program focused on improving these methodologies and techniques to provide improved feedback for the baiting program.

For the Fortescue cat baiting work each year will be treated as an independent event testing the impact of cat baiting. Therefore, comparison of baiting efficacy pre and post bait delivery in the year of treatment is the aim of occupancy modelling, rather than comparison between years. Given the high possibility of invasion of cats from outside the baiting area, comparison between years may not give a true indication of occupancy. With a sustained baiting effort it can be expected that occupancy would decrease over time.

During 25-29 May, a total of 31 (control 1) and 14 (control 2) camera-trap survey sites were established in the control cells (Figure 8) and 29 camera-trap survey sites were established in the baited cell (Figure 9). Survey sites in the control cells were located a minimum of 5 km (estimated home range of a feral cat, D. Algar pers comm.) from the boundary of the baited cell. A further 21 camera-trap survey sites were established immediately adjacent (north) of the baited cell in the buffer between control 2 site and the baited area to provide a representative sample across the entire marsh and to take advantage of the opportunity to survey areas that may be inaccessible during wet seasons. Data from the camera sites in the buffer were not used for the site occupancy modelling as they were located within 5 km of the bait zone.

Lures for the camera-trap surveys consisted of a spice jar with holed lid containing an oil-based scented lure (Catastrophe, Outfoxed Victoria) which was attached to a wooden stake approximately 30cm from the ground. A 1.5m long bamboo cane was joined to the wooden stake, with white synthetic turkey feathers connected to the cane approximately 30cm above the scented lure and a strip of wired silver tinsel was taped to the top of the cane. Cameras (HC600; Reconyx, Wisconsin, USA) were set horizontally, approximately 30cm from the ground (Figure 10). Cameras were set on “Scrape” program which records 5 pictures per trigger, and picture interval is on “RapidFire” which is 2 frames per second. There is no quiet period.

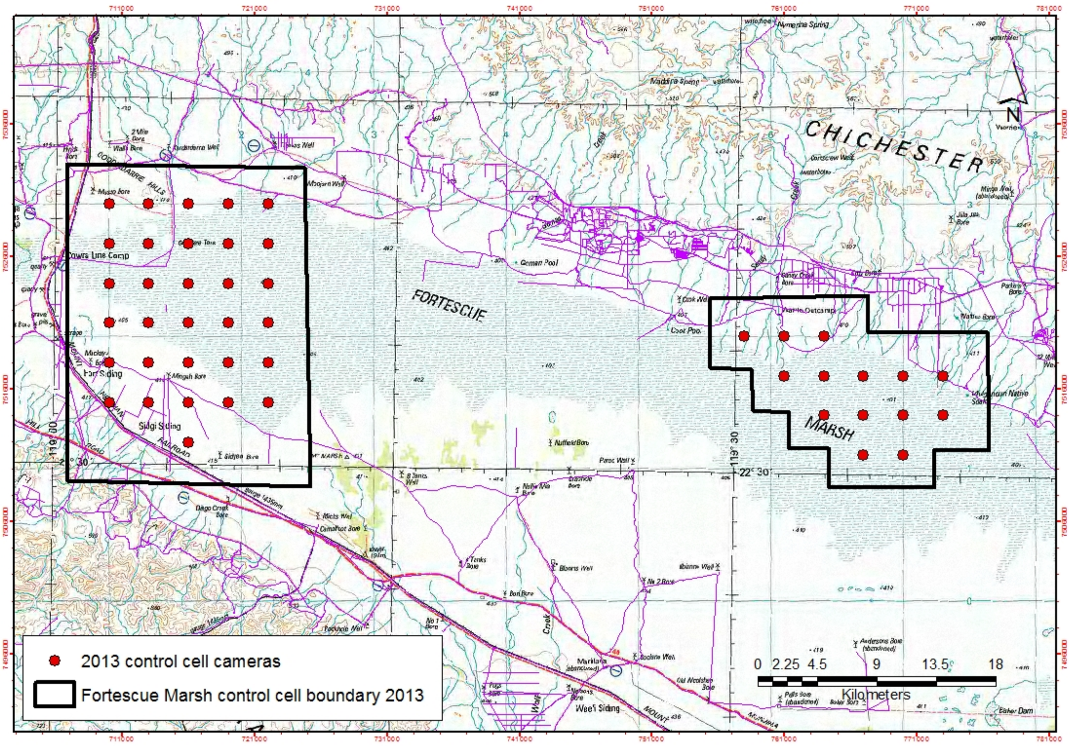


Figure 8. Remote camera-trap survey sites (control) at Fortescue Marsh in 2013

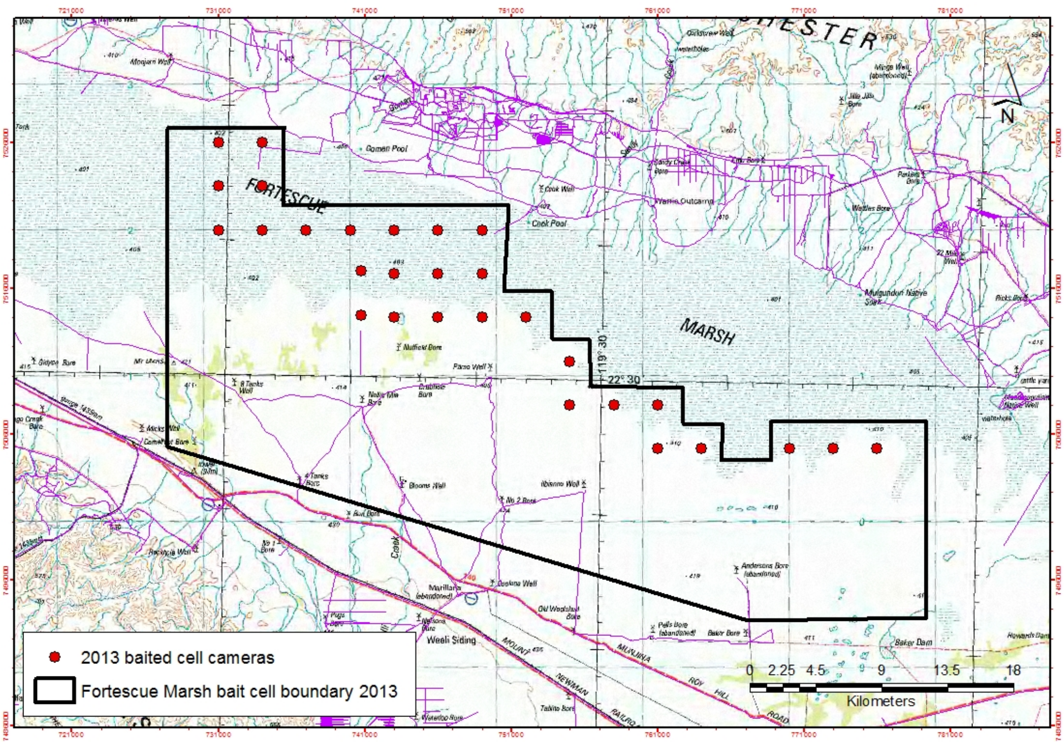


Figure 9. Remote camera-trap survey sites (baited cell) at Fortescue Marsh in 2013

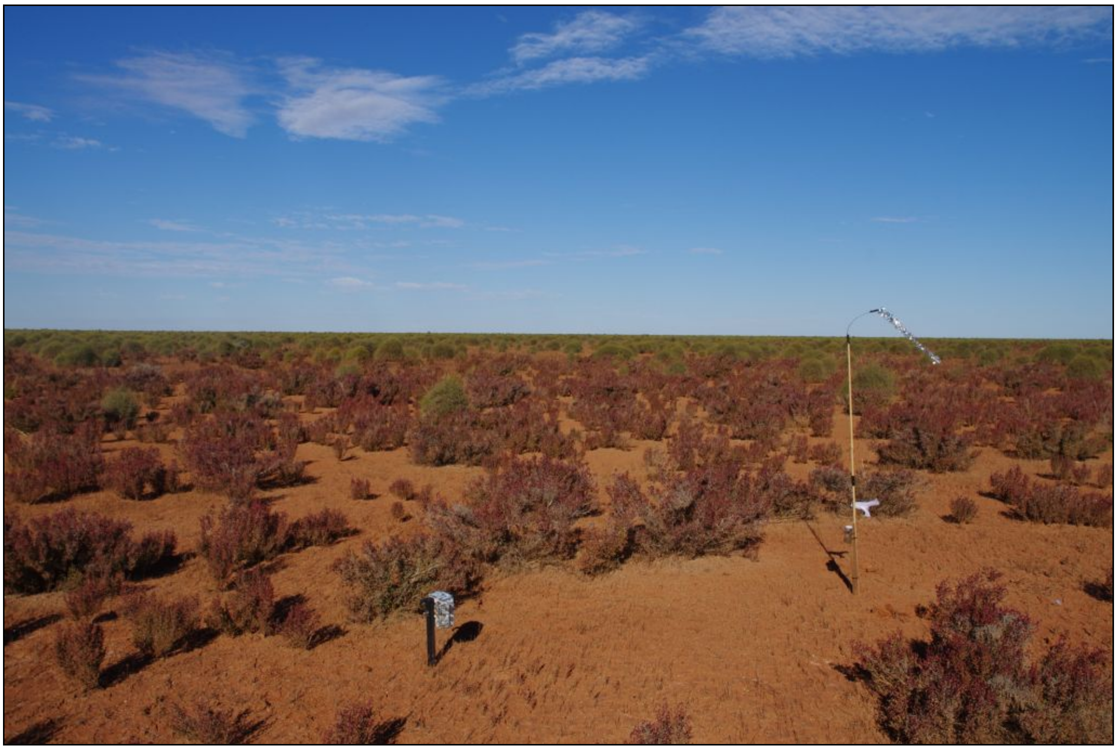


Figure 10. Image of the camera-trap site set-up at Fortescue Marsh, 2013

Presence/absence data from feral cats were collected during 30 May-15 June for the pre-bait monitoring period and during 20 July-16 August for the post-bait monitoring period. All other monitoring activity was ceased during the periods of remote camera data collection to ensure human disturbance did not affect the movements/behaviour of introduced predators for a minimum of 14 days. Lures were removed during 20 June-16 July to reduce the effect of individuals becoming used to, and thus reducing the effectiveness of the lure, for the post-bait camera-trap surveys. Cameras and lures were removed from the field following the post-bait monitoring period.

Feral cat trapping around mine-related infrastructure

In the week commencing 22 July, 101 medium Sheffield traps were transported to the Cloudbreak camp from Albany. On 20 August, a total of 46 traps were set around Cloudbreak, including the camp, the waste disposal facilities and the water recycling point near the camp. An additional 54 traps were established at the two camps (i.e. Karntama and Construction camps) and the waste disposal facility at Christmas Creek (Appendix A). Traps were placed in likely feral cat paths and were baited with fried chicken pieces, cooked sausage or a tinned tuna/pilchards mix. Trapped cats were administered a sedative (Zoletil) at a rate of 4mg/kg. When the cat became unconscious, a barbiturate (Lethobarb) was administered by injection directly into the heart to euthanize the animal.

Details recorded included sex, neck girth, weight, age (adult or juvenile), pelage and number of unborn young. Samples collected included stomach, ear tissue and hair. Stomach samples provide an indication of preferred feral cat prey items, determined by laboratory analysis. Stomachs were removed intact from the cat and stored in

100% ethanol prior to dissection with a scalpel blade. The stomach contents were extracted and placed in a large dish and using forceps whole animals (e.g. mice), insects, bait (used to lure cat in trap) were removed and identified. Animal parts such as bird feet, claws, beaks, feathers, teeth, skulls, insect body parts were separated and identified or stored in individual vials with ethanol for further identification. Multiple hair samples were taken throughout the remaining stomachs and identified under microscope to species level.

Efforts were made to identify prey to species level, but identification of bird feathers, reptiles, invertebrates and plant material need specialist skills and have not been completed in the reporting timeframe.

2.6 Non-target species

2.6.1 Targeted bird surveys

2.6.1.1 Site selection

Locations for point-count bird surveys and Autonomous Recording Unit (ARU) deployment were based on existing camera-trap survey locations, selected on the basis of habitat characteristics with the assumption that relationships with habitat diversity (i.e. species and structure) would be correlated for both cats and birds. Each camera-trap survey point was ranked on vegetation coverage, structure and type. Locations with high coverage of native vegetation (e.g. spinifex (*Triodia* spp.)) and structural diversity were given preference over locations with non-native species (e.g. buffel grass (*Cenchrus ciliaris*)), low coverage and low structural diversity (e.g. bare ground).

Of the original 64 camera-trap survey points located within the proposed baited cell, 22 survey sites were selected as most suitable for ARU deployment and point-count bird surveys. Seventeen sites were selected by random-number generation for ARU deployment from the 22 suitable sites identified. The selected sites were compared with camera-trap surveys where feral cats were recorded in 2012. Of the nine locations where cats were recorded in 2012 (of camera-trap survey sites re-used in 2013), seven were independently selected for bird surveys simply by using habitat attributes, consistent with our assumption that diversity of vegetation type and structure can (to some degree) predict the occurrence of feral cats. Figure 11 provides the location of ARU and point-count surveys for birds during 2013.
All bird surveys were conducted outside the period of camera-trap surveys to ensure that the effect of human disturbance on the detectability of cats was kept to a minimum.

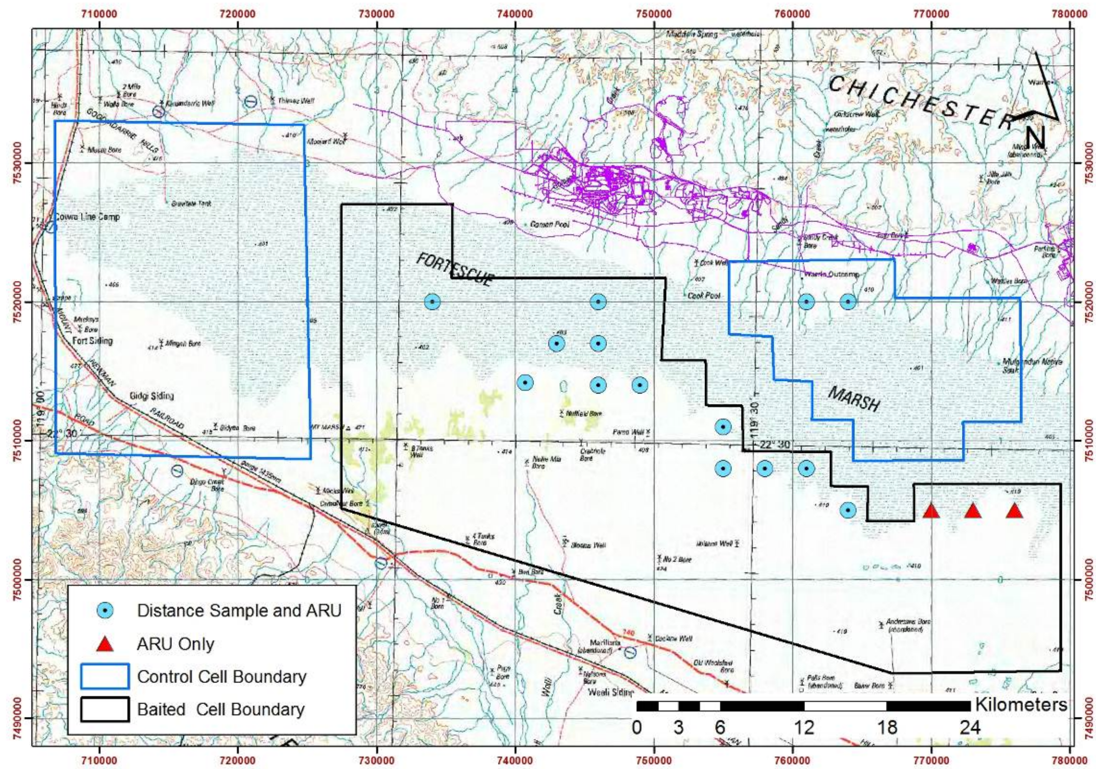


Figure 11. Location of ARU and point-count surveys for birds at Fortescue Marsh, 2013

2.6.1.2 Point count surveys

Point-count surveys with distance estimation (using the basic assumption that detectability of birds is inversely proportional to the distance from the observer) are a widely used sampling tool for the estimation of diversity and abundance of bird species in a survey area (Bibby *et al*. 2000). Point-count surveys were carried out by two teams of two for 20 minutes, either immediately prior to or within two hours following sunrise. Fifteen surveys were completed (from 17 suitable locations), usually averaging two surveys per team per morning, during 17- 23 June, 2013. All birds seen or heard during the 20 minute period were recorded and an estimate made of the distance from the observers. A laser range-finder was used to estimate distances for distance-sampling. However, this technology proved difficult to use in areas with low vegetation of uniform height (e.g. chenopod shrubland; spinifex grassland etc), where visual estimates of distance were more practical. While every effort was made to undertake surveys as close to sunrise (~06:38 h) as possible, the need to travel relatively long distances (up to 25km) at a safe speed in darkness often made this impractical. However, all surveys were completed within two hours of sunrise, which is still within the presumed daily peak period of bird activity. Survey effort was also precluded due to heavy rain on 18 June, which prevented access to the marsh by four-wheel drive vehicle and quad bikes for a 24 hour period.

2.6.1.3 Autonomous recording units (ARUs)

ARUs (Song Meter SM2+, Wildlife Acoustics, Massachusetts, USA) were deployed at all 17 locations that were designated as the most suitable for birds and cats. Units were programmed to commence recording one hour before sunrise and two hours before sunset and continue recording for three hours, giving a total of six hours recording time per 24 hour period. These recording cycles aimed to capture the period of peak bird activity at dawn and dusk. One hour of recording pre-sunrise and post-sunset was included to increase the possibility of detecting calls of the Night Parrot (*Pezoporus occidentalis*), which are understood to be predominantly nocturnal (Blyth 1996).

ARUs were deployed close to camera-trap locations (≤5m away) and fixed to two metal dropper-posts with cable-ties (Figure 12). A microphone with wind-sock was attached to external ports on each side of the unit, which allow the units to record external sound. ARUs were deployed on the 16-17 June and collected on the 17-18 July.

Analysis of ARU recording data was performed using the bioacoustics software Syrinx (Burt 2001), which displays audio in a spectrogram format, thereby allowing calls from different bird species to be discerned visually. Recordings were screened manually for bird calls, which were then identified aurally with subsequent calls identified visually from characteristic patterns on the spectrogram. Bird calls were identified to species level and a list of species was recorded for each three hour recording. Calls that could not be identified were referred to A.H. Burbidge and J. Raines for further examination and subsequent identification.

Figure 12. Autonomous Recording Unit and camera-trap deployment in spinifex (*Triodia* spp.) grassland on Fortescue Marsh, June 2013

2.6.2 Incidental records

2.6.2.1 Birds

During four of the five field survey trips made to Fortescue Marsh by the DPaW/IFRP team in 2013, opportunistic bird observations were recorded to provide an indicative list of bird species present in and around the marsh during the period May to August. Records were designated either as in the treatment and/or control cells or solely recorded in areas immediately adjacent to these cells (e.g. Kardardarrie Well; Cloudbreak Mine and camp). As the error with the navigation files occurred after commencing the collection of incidental data, species recorded 'in the treatment cell' refer to the planned bait cell, not the actual 2013 bait cell. These records were added to the overall list of bird species recorded since the program commenced in June 2012.

In addition to species observed/heard directly during the course of the 2013 Fortescue Marsh program, a number of bird species were recorded on camera-traps and these records were included in the overall species list for the area. Camera-traps provide an additional source of data as shown in 2012, where some bird species were only recorded on cameras. Furthermore, camera-traps have been used successfully to estimate species richness in other studies (e.g. O'Brien *et al*. 2011) and may prove a useful source of general biodiversity data over the course of this program.

2.6.2.2 Mammals

Incidental records of mammals included sightings, scats, tracks and diggings were recorded by the DPaW/IFRP team during fieldwork at Fortescue Marsh. Furthermore, where possible, identification of mammals during the remote camera-trap surveys was also recorded. Stomach samples from feral cats also provide an indication of the distribution of some native mammal species.

3 Results

3.1 Feral cat trapping

Nine cats were trapped, comprising five male and four females (Table 5). Seven cats were captured on the (FAP + pongo) lure and two were captured on the (pongo) lure. The location of cat captures is provided in Figure 7. All cats appeared to be in excellent body condition and searches for ectoparasites proved negative.

Table 5. Capture records of feral cats, Fortescue Marsh 2013

Date	Sample No	Trap No	Sex (M/F)	Weight (kg)	Coat colour	Age	Radio-collar frequency (Mg Htz)
24/5/2013	FMG 1	T 24	F	2.0	Tabby	Sub-adult	151.762
24/5/2013	FMG 2	T 17	M	5.3	Black	Adult	149.561
25/5/2013	FMG 3	T 62	F	1.8	Black	Sub-adult	148.902
26/5/2013	FMG 4	T 34	F	2.1	Tabby	Adult	150.923
27/5/2013	FMG 5	T 23	M	4.0	Tabby	Adult	151.320
27/5/2013	FMG 6	T 66	F	3.3	Tabby	Adult	151.862
28/5/2013	FMG 7	T 28	M	2.2	Tabby	Adult	151.902
28/5/2013	FMG 8	T 60	M	3.0	Tabby	Adult	148.940
29/5/2013	FMG 9	T 52	M	3.6	Tabby	Adult	150.062

In addition to the feral cats, several non-target species were captured; their number and trap location are described in Table 6. The wild dog/dingo hybrids (*Canis familiaris)* were euthanized, the rest were released unharmed apart from one Barn Owl (*Tyto alba*) and one Brown Goshawk (*Accipiter fasciatus*), which were euthanized because of trap injuries.

Table 6. Non-target species captured, their number and trap location

Species	Number	Trap number
Brown Falcon (*Falco berigora*)	2	T 20, T 41
Barn Owl (*Tyto alba*)	7	T 8, T 38, T 54, T 38, T 48, T 16 , T 4
Collared Sparrowhawk (*Accipiter cirrocephalus*)	1	T 16
Brown Goshawk (*Accipiter fasciatus*)	3	T 20, T 22, T 8
Wild Dog/Dingo (*Canis familiaris*)	5	T 57, T 72, T 63, T 16, T 6

3.2 *Collared feral cats*

3.2.1 *Recovery of feral cats*

GPS location data were retrieved from seven of the nine radio collared cats. Two dead cats were located still wearing their radio collars and since the drop-off mechanisms had activated, this suggests the cats had died before this programmed drop-off. Two collars were retrieved after the drop-off mechanism released the collar from a live cat (i.e. no cat found with the collar), and two collars fell off the cats prematurely due to a manufacturing error. The remaining cat was shot by staff on the ground after being located by helicopter.

Details of the sampling duration, number of data points achieved (after filtering), and the method of collar retrieval for each sample are summarised in Table 7.

Table 7. Details from radio-collars on each collared cat

Sample No.	Duration of filtered data	Total no. of filtered data points	Date of collar retrieval	Method of collar retrieval
FMG 1	N/A	N/A	N/A	Not retrieved
FMG 2	25 May - 14 July	1212	16 August	Helicopter
FMG 3	26 May - 2 June	191	16 August	Helicopter
FMG 4	27 May - 20 June	590	16 August	Helicopter
FMG 5	28 May - 4 June	181	16 August	Helicopter
FMG 6	28 May - 4 June	214	17 July	Field
FMG 7	29 May - 2 June	119	16 August	Helicopter
FMG 8	29 May - 20 July	1264	16 August	Helicopter
FMG 9	N/A	N/A	N/A	Not retrieved

A carcass of a feral cat was located at 743085E 7514082N (see Figure 13). This cat was likely recorded on camera on 5 June, prior to the baiting. Although it cannot be determined beyond doubt, the location and state of decay suggested that mortality was likely due to baiting.

3.2.2 *Feral cat activity*

Data sourced from the radio collars indicate that the average daily distance travelled by collared feral cats at Fortescue Marsh varied considerably (Table 8). Home range values were only available for three collared cats as, for various reasons, the other collars did not produce sufficient data (i.e. three weeks or 504 data points). Once plotted, closer inspection revealed that the feral cats were significantly affected by human presence/activity, with a number of cats spending considerable time within the active Cloudbreak mine cell (Figure 14).

a)

b)

Figure 13a & 13b. Images of feral cat (a) and carcass (b) located at Fortescue Marsh, 2013

Table 8. Collared feral cat movement data, Fortescue Marsh 2013

Sample No	Trap No.	Sex	No. data points	Distance per day (m) (av ± sd)	Home range (ha)	
					MCP100	MCP95
FMG 2	T 17	M	1212	6215.3 ± 2546.4	2725.5	2418.8
FMG 3	T 62	F	191	5719.2 ± 2643.8	N/A	N/A
FMG 4	T 34	F	590	2831.3 ± 1610.9	3683.7	2870.1
FMG 5	T 23	M	181	1841.8 ± 1406.6	N/A	N/A
FMG 6	T 66	F	214	2720.3 ± 1211.9	N/A	N/A
FMG 7	T 28	M	119	4744.9 ± 953.6	N/A	N/A
FMG 8	T 60	M	1264	3556.4 ± 1105.4	1303.8	1033.5

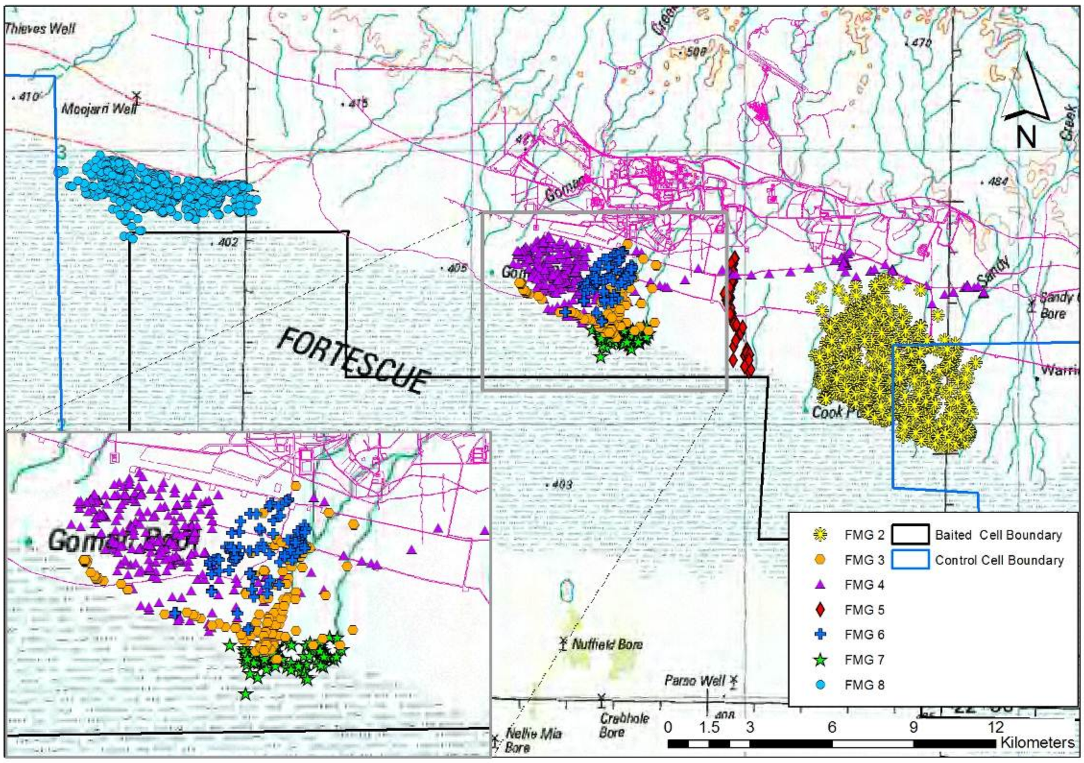


Figure 14. GPS collar locations for 7 out of 9 cats collared at Fortescue Marsh (Inset shows enlarged area of locations for cats FMG 4, 6 and 7)

The data sourced from the retrieved radio collars also provided an insight into the temporal movement of feral cats at Fortescue Marsh. The combined data from all collars identified a bimodal distribution pattern with a peak in activity in the hours immediately following sunset and another smaller peak 12 hours later, immediately following sunrise (Figure 15).

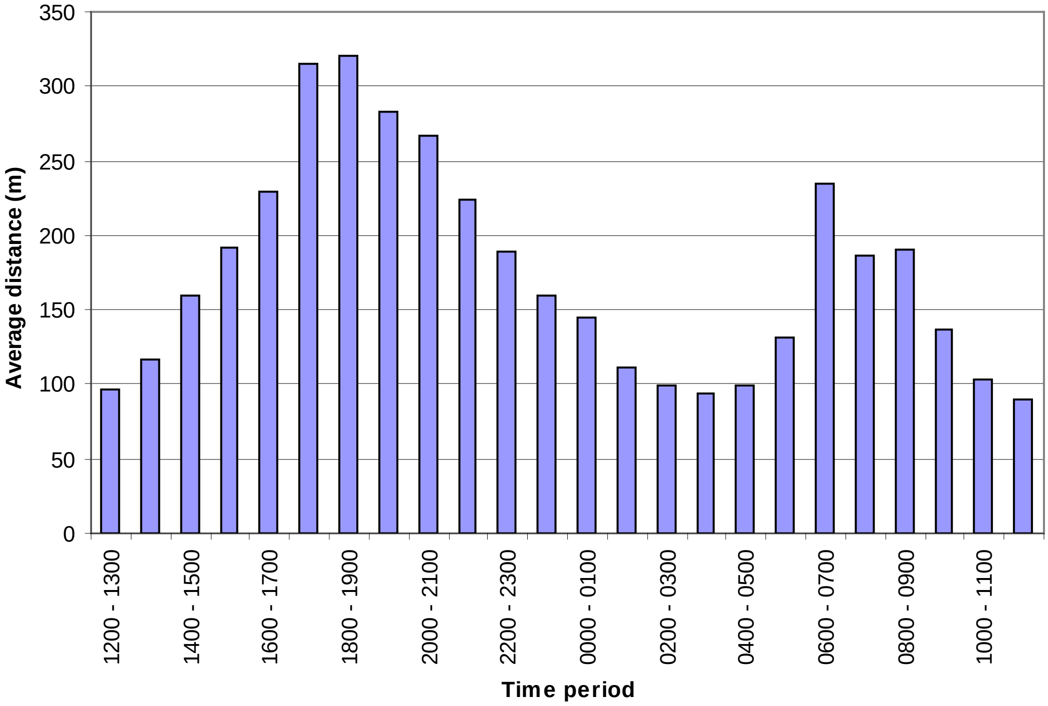


Figure 15. Temporal movement pattern of collared feral cats at Fortescue Marsh, 2013 (156 samples per hourly time period using data from cats shown in Table 8)

3.3 Feral cat site occupancy using camera-traps

For occupancy modelling, data from each remote camera-trap is required to be collected over the same period, despite cameras being commissioned and decommissioned on different, consecutive, days. Therefore, the total number of remote camera-trap nights exceeds the number of nights that can be used for the modelling (Table 9). However, the data collected outside these periods can be considered as records for the identification of native and introduced species and is, therefore, worthy of record.

Table 9. Camera-trap nights recorded during 2013

Study period & site	Maximum no. trap nights for occupancy modelling	Total no. trap nights
Pre-bait control 1	527	710
Pre-bait control 2	238	258
Pre-bait Buffer	N/A	390
Pre-bait treatment	493	543

Post-bait control 1	868	903
Post-bait control 2	392	406
Post-bait Buffer	N/A	609
Post-bait treatment	812	841

A total of 4,660 camera-trap nights was recorded, with feral cats recorded at 21 of 95 camera-trap sites throughout the study area. Feral cat records during all remote camera-trap surveys are presented in Figure 16 and Appendix C, including the number of camera-trap sites, events (i.e. number of visits to the camera-trap site), and an estimate of the number of individual feral cats based on visual identification.

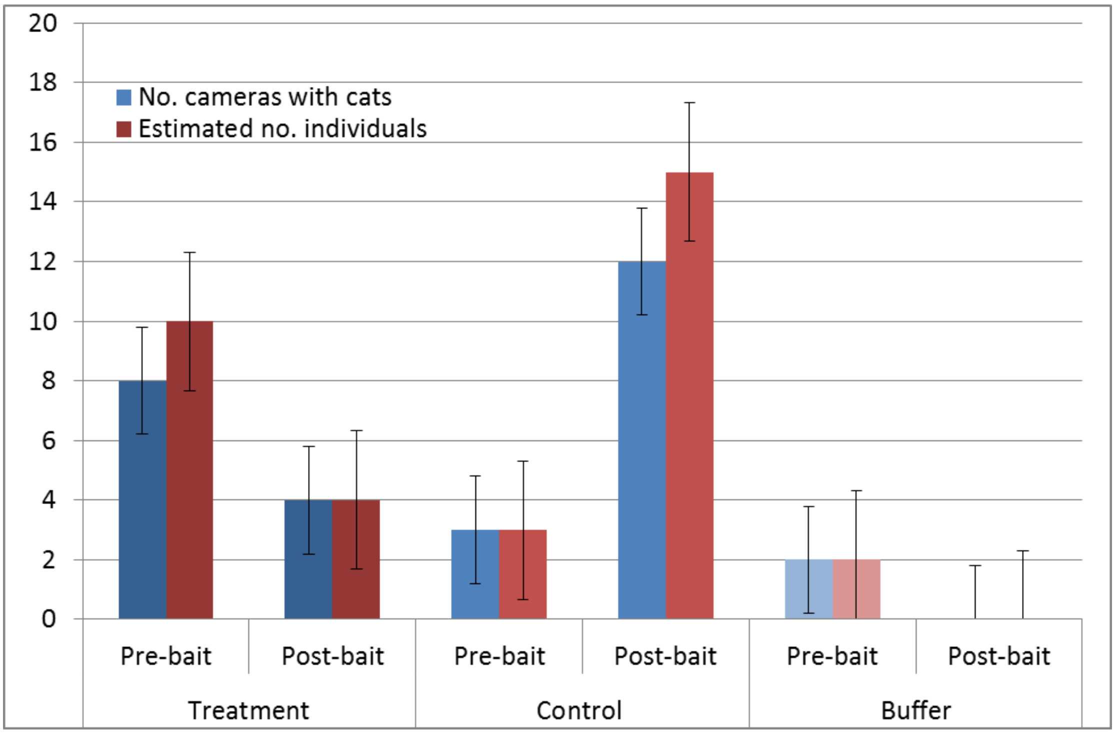


Figure 16. Number of feral cats recorded at camera-trap survey sites during pre- and post-baiting periods in treatment, control and buffer cells

Figure 17 presents the distribution of feral cat records from the remote camera-trap surveys throughout the entire Fortescue Marsh study site. Feral cats were recorded throughout most areas of the marsh, although they were primarily located along the margins of the marsh.

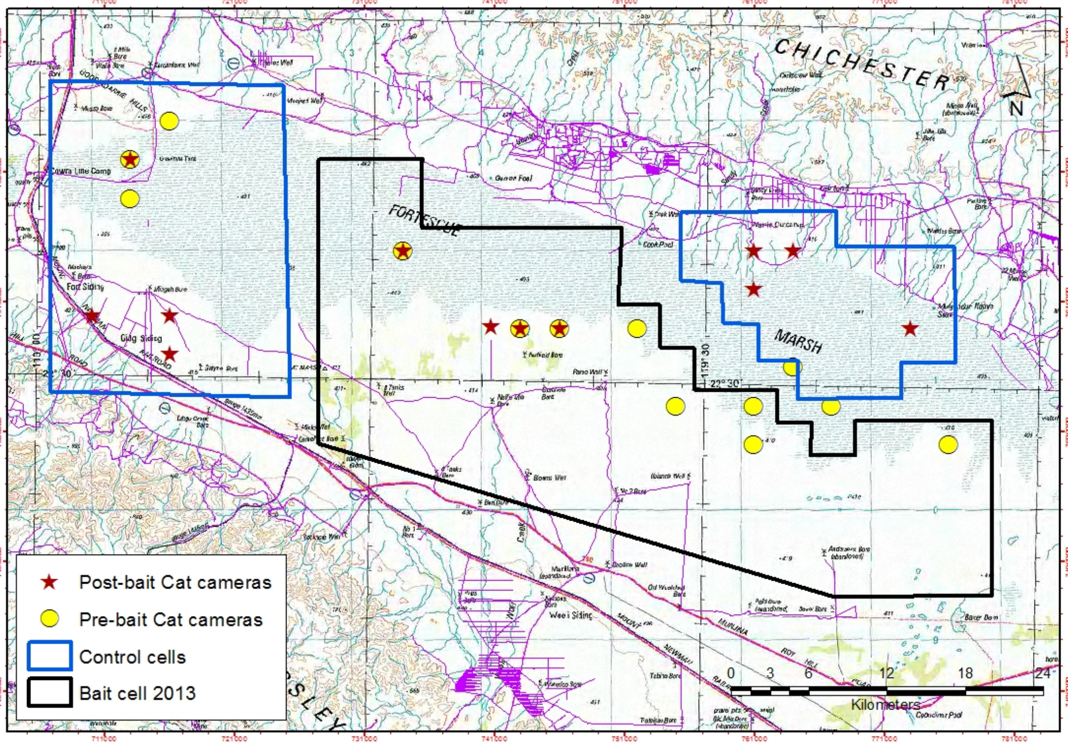


Figure 17. Location of positive records for feral cats during all remote camera surveys at Fortescue Marsh, 2013

There is a highly significant decline (one-tailed t=3.479, n=29, $p<0.05$) in the occupancy of the baited area by feral cats post-baiting (Table 10, Figure 18). Although this result initially suggests that baiting had a considerable impact on the feral cat population, this result is magnified by a significant increase (one-tailed t=9.908, n=44, $p<0.05$) in the occupancy of the control area by feral cats over this same period.

Table 10. Probability of occupancy (±SE (95%CI)) with no habitat covariates

	Pre-bait	Post-bait
Control (n=44)	0.04896 ± 0.0449	0.3013 ± 0.1628
Treatment (n=29)	0.6449 ± 0.1868	0.4524 ± 0.2321

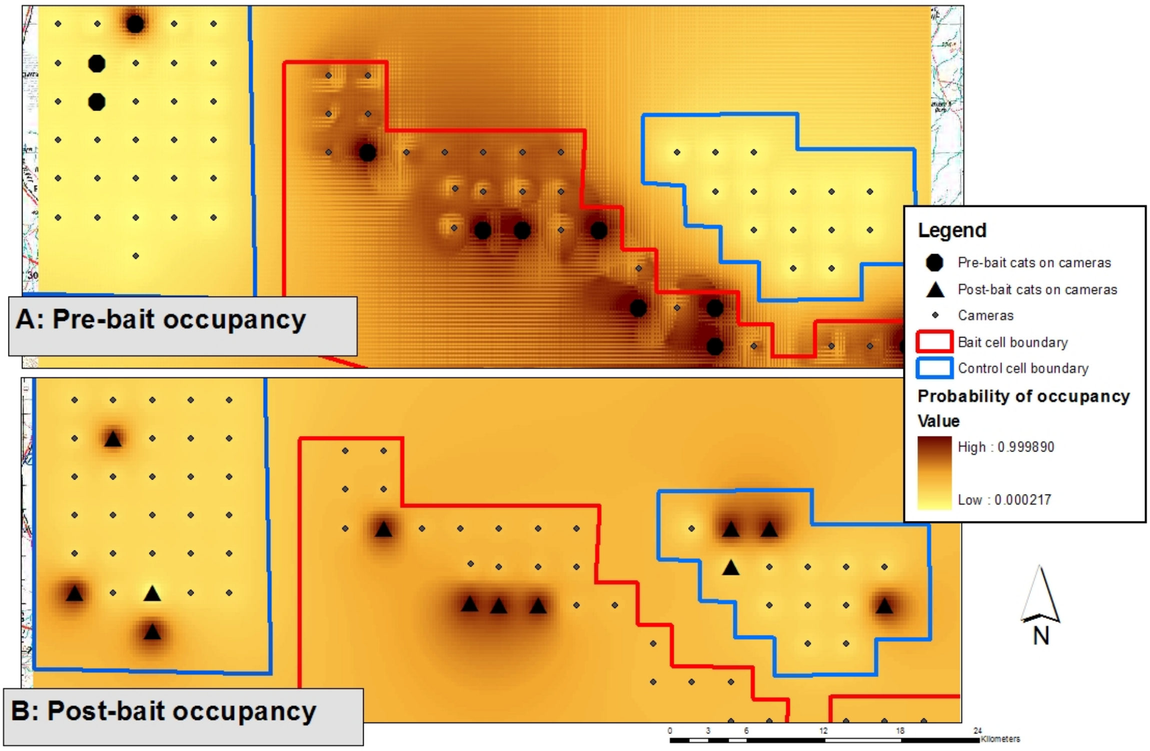


Figure 18. Probability of feral cat site occupancy at Fortescue Marsh pre and post delivery of Eradicat® baits, 2013 with individual cats captured on cameras marked (note: some individual cats detected outside period of occupancy modelling))

3.4 Feral cats captured around mine-related infrastructure

Five cats were trapped at the two Christmas Creek Camps, comprising one male and four females. A sixth cat was captured by FMG environmental staff at the Cloudbreak water towers near the mining site offices (Table 11). Non-target species captured included several House Mice (*Mus musculus*) at Cloudbreak and Yellow-spotted Monitors (*Varanus panoptes*) at each of the Karntama Camp and Construction camps at Christmas Creek (Table 12). The cat stomach contents revealed a mixture of prey items with a likelihood that their diet mainly consisted of human food scraps (Table 11). Trap location overview is provided in Appendix A.

Table 11. Results from feral cat trapping around selected mine-site infrastructure at Cloudbreak and Christmas Creek

Sample No.	Date	Location Description	Trap No.	Sex	No. of foetus	Weight(g)	Coat
1KF13	22/08/2013	Karntama Village - Dining Hall	K11	Female	5	4600	Tabby
1CM13	22/08/2013	Construction Camp - inside Maintenance	Con3	Male	NA	4900	Ginger
2CF13	22/08/2013	Construction Camp - outside Maintenance	Con2	Female	0	2100	Tabby
2KF13	23/08/2013	Karntama Village - Reflection room	K25	Female	3	3250	Tabby
3CF13	25/08/2013	Construction Camp - Dining Hall	Con9	Female	3	3375	Tabby
4CM13	26/08/2013	Cloudbreak Mine - Watertanks on hill	Water tanks	Male	NA	2500	Tabby

Table 12. Non-target species captured, their number and trap location

Species	Number	Trap number
House Mouse (*Mus musculus)*	5	CBT16, CBTip3, CBTip9x2, CBTip23
Yellow-spotted Monitor (*Varanus panoptes*)	1	KarT12,
Unidentified Monitor (*Varanus* sp.) *	1	ConT19

*released overnight by FMG staff

Table 13. Analysis of stomach contents from feral cats trapped around mine-site infrastructure

Sample No.	Location	Stomach Contents
1KF13	Karntama Village	no stomach collected
1CM13	Construction Camp	numerous bird feathers
2CF13	Construction Camp	cat hairs, numerous insect species
2KF13	Karntama Village	cat hairs, bird feathers, 2x bird feet, numerous insect species
3CF13	Construction Camp	cat hairs
4CM13	Cloudbreak Mine	*Mus musculus*, insect species
FMG5	Fortescue Marsh* (North side)	*Mus musculus*, bird feathers, 1x bird leg, 3x reptile claws,1x reptile body parts, cat hairs

* collared cat re-captured in vicinity of marsh

3.5 Targeted bird surveys

3.5.1 Distance sampling

No avian species listed under the WA Wildlife Conservation Act were recorded during the distance sampling surveys conducted at Fortescue Marsh during June 2013. Table 14 presents data of the species recorded, the number of surveys during which each species was recorded, and the percentage of seen/heard records of each species. Species listed under the EPBC Migratory Species List are recorded in Table 14. Further analysis is required to determine the diversity and abundance estimates.

Table 14. Summary of data recorded from distance sampling surveys at Fortescue Marsh, June 2013

Species	EPBC Migratory Species List	No. surveys	observation method		No. individuals recorded
			% Heard	% Seen	
Australasian Pipit		1	100.0		1

Australian Hobby	*	1		100.0	1
Australian Pratincole		1		100.0	15
Black Honeyeater		8	68.8	31.3	18
Black-shouldered Kite	*	1		100.0	1
Brown Falcon	*	1		100.0	1
Brown Songlark		2	100.0		4
Budgerigar		3	40.0	60.0	68
Chestnut-rumped Thornbill		2	100.0		2
Cockatiel		1		100.0	1
Common Bronzewing		1	100.0		1
Crested Bellbird		6	100.0		10
Crested Pigeon		3	75.0	25.0	4
Crimson Chat		3	66.7	33.3	4
Fairy Martin		1		100.0	2
Grey Butcherbird		1	100.0		1
Horsfield's Bronze-cuckoo		1	100.0		1
Horsfield's Bushlark		3	33.3	66.7	3
Magpie-lark		1	100.0		1
Masked Woodswallow		2	100.0		5
Orange Chat		1		100.0	3
Pied Butcherbird		6	87.5	12.5	8
Pied Honeyeater		3	42.9	57.1	44
Red-capped Robin		1	100.0		1
Rufous Whistler		1	100.0		1
Singing Honeyeater		9	100.0		22
Spiny-cheeked Honeyeater		2	50.0	50.0	4
Torresian Crow		2	50.0	50.0	2
unknown 1		1	100.0		1
unknown 2		1	100.0		1
Whistling Kite	*	1		100.0	1
White-plumed Honeyeater		2	100.0		6
White-winged Fairy-wren		9	91.7	8.3	14
White-winged Triller		1		100.0	3
Willie Wagtail		3		100.0	3
Zebra Finch		7	38.5	61.5	35

* Included under the EPBC Migratory Species List (JAMBA/CAMBA/Bonn Convention)

3.5.2 Automated Recording Units (ARUs)

Regardless of the equipment failure of one ARU, the remaining 16 units recorded a total of 822 hours of sound recordings over the nine-day survey period. The length of the survey period was limited by the capacity of the SD memory cards (i.e. 16GB). However, the value of data yielded from a greater number of hours of recordings is limited by the time and resources required to process the data. The ARU data collected during these surveys is currently being analysed, however a sample of three hours from both morning and evening recordings on a single day at each ARU site has been completed to provide preliminary results.

Table 15 presents data from a total of 32 samples (i.e. 16 ARUs during morning and evening surveys), with no species recorded in all samples. As expected, a considerably greater number of records came from morning surveys than evening surveys (am = 108, pm = 65). There were no avian species listed under the WA Wildlife Conservation Act or EPBC Migratory Species List recorded during the ARU surveys conducted at Fortescue Marsh during June 2013.

Table 15. Preliminary results from ARU recordings at Fortescue Marsh, June 2013

Common Name	Scientific Name	Total	am	pm
Acanthiza sp.	*Acanthiza* sp.	4	2	2
Australasian Pipit	*Anthus novaeseelandiae*	2	2	0
Australian Pratincole	*Stiltia isabella*	1	1	0
Australian Ringneck	*Barnardius zonarius*	1	1	0
Black Honeyeater	*Sugomel niger*	15	10	5
Black-faced Woodswallow	*Artamus cinereus*	1	0	1
Brown Songlark	*Cincloramphus cruralis*	4	2	2
Budgerigar	*Melopsittacus undulatus*	12	11	1
Cockatiel	*Nymphicus hollandicus*	2	2	0
Crow sp.	*Corvus* sp.	10	5	5
Crested Bellbird	*Oreoica gutturalis*	7	4	3
Crested Pigeon	*Ocyphaps lophotes*	3	1	2
Crimson Chat	*Epthianura tricolor*	7	5	2
Horsfield's Bronze-cuckoo	*Chalcites basalis*	2	1	1
Horsfield's Bushlark	*Mirafra javanica*	2	2	0
Magpie-Lark	*Grallina cyanoleuca*	2	1	1
Masked Woodswallow	*Artamus personatus*	3	2	1
Pied Butcherbird	*Cracticus nigrogularis*	6	6	0
Pied Honeyeater	*Certhionyx variegatus*	12	8	4
Babbler sp.	*Pomatostomus* sp.	1	1	0
Rufous Whistler	*Pachycephala rufiventris*	1	1	0
Singing Honeyeater	*Lichenostomus virescens*	15	8	7
Spinifexbird	*Eremiornis carteri*	9	5	4
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	4	2	2
Variegated Fairy-wren	*Malurus lamberti*	2	0	2
White-fronted Honeyeater	*Purnella albifrons*	4	3	1
White-plumed Honeyeater	*Lichenostomus penicillatus*	3	2	1
White-winged Fairy-wren	*Malurus leucopterus*	25	13	12
Willie Wagtail	*Rhipidura leucophrys*	3	1	2
Zebra Finch	*Taeniopygia guttata*	4	3	1
Total		**173**	**108**	**65**

3.6 Incidental records of native species (including data from camera surveys)

3.6.1 Bilby habitat

During the establishment of remote cameras for survey during May 2013, members of the DPaW/IFRP team observed a number of sites with diggings presumed to have been created by Bilby (*Macrotis lagotis*) (see Figure 19). These were observed in the general vicinity (<3km) of a remote camera-trap (within the Marillana pastoral lease) that captured a record of this species during 2012 camera-trap surveys. Managers of the Marillana pastoral lease removed this area from active pastoral activities a number of years ago and although there is evidence of stray cattle, there has been a noticeable recovery of vegetation in the area. While there were no fresh signs of Bilby activity observed (e.g. scats, fresh diggings etc) it is likely that further targeted surveys could identify recent activity.

3.6.2 Mammals

There were no threatened mammal species recorded during camera-trap surveys; data presented in Table 16. With generally less vegetation at sites within the buffer area between the treatment and control 2 sites and mostly in the middle of the marsh, the cameras picked up fewer kangaroos and cattle but surprisingly still caught a number of small mammals.

Table 16. Native mammal species identified during remote camera-trap surveys and percentage of cameras at each study site with species present

Common name	Scientific name	% cameras (baited)	% cameras (control 1)	% cameras (control 2)	% cameras (buffer)
Red Kangaroo	*Macropus rufus*	20.69	35.48	21.43	0.00
Little Red Kaluta	*Dasykaluta rosamondae*	10.34	3.23	0.00	0.00
Spinifex Hopping-mouse	*Notomys alexis*	10.34	16.13	0.00	0.00
Unidentified dunnart sp.	*Sminthopsis spp.*	3.45	6.45	14.29	9.52
Unidentified small mammal		41.38	32.26	7.14	19.05
Cattle	*Bos taurus*	13.79	6.45	35.71	9.52
Feral Cat	*Felis catus*	31.03	19.35	28.57	9.52
Wild Dog/Dingo	*Canis familiaris x dingo*	6.90	6.45	0.00	0.00
European Rabbit	*Oryctolagus cuniculus*	6.90	3.23	0.00	0.00
Camel	*Camelus dromedarius*	0.00	0.00	0.00	4.76

a)

b)

Figure 19a & 19b. Images of presumed Bilby activity, Fortescue Marsh 2013

3.6.3 Birds

Although the greatest diversity of species was recorded in June, this is most likely due to the extra observer effort by the bird survey team during this period (Table 17). Similarly with a greater survey effort concentrated within the baited area, more species were identified. A full list of avian species recorded in both 2012 and 2013 is provided as Appendix B.

Table 17. Incidental record of bird species richness during field surveys, 2013

	Camera	ARU	18/5/13-31/5/13	16/6/13-23/6/13	15/7/13-20/7/13	16/8/13-27/8/13
Bait cell only	0	0	32	51	41	41
Control area only	0	0	0	1	0	0
Both baited and control areas	20	29	30	26	7	0
Adjacent to baited and control areas	0	0	6	4	1	10
Total	20	29	68	82	49	51

4 Discussion

The primary aim of the Fortescue Marsh feral cat baiting program is to trial and assess the efficacy of the *Eradicat*® bait in reducing the threat of feral cat predation to native species at a semi-arid mainland site. The results from occupancy modelling in 2013 found that there was a significant decrease in numbers of feral cats in the treatment cell post baiting, which is similar to results being obtained from broad-scale aerial baiting elsewhere in the state (Algar *et al*., 2013 in press; Comer *et al*., 2013 in press).

Work completed in 2013 provided important information on improving the delivery and monitoring of baiting efficacy. For example, bait delivery was improved with aid of a carousel to maintain the preferred pattern of distribution. The use of remote cameras has proven invaluable for providing a robust technique to assess baiting efficacy.

Site occupancy modelling using data collected by remote camera-trap surveys suggests there has been a significant decline in the feral cat population after baiting, which contrasted strongly with a significant increase modelled for the control cell. This was largely due to an increase in post-baiting detections in the control, whereas post-bait detections decreased significantly in the treatment cell. A possible explanation for this difference (aside from the impact of baiting on the treatment cats) may be the unusual climatic conditions between April and July, which may have led to a greater abundance of prey, prompting increased activity levels (and therefore chances of detection) on remote camera-traps. However, another more likely explanation is that the post-bait monitoring period in late July/early August coincides with the commencement of reproductive activity associated with increasing day length. Changes in day length have been shown to induce oestrous in domestic cats (Hurni 1981) and therefore it is reasonable to expect that during the post-bait period the activity and mobility of cats will increase. However, regardless of whether climate or day length (or both in combination) has influenced the detection rate of cats, the observed and modelled increase in cats both highlights and magnifies the impact of baiting on cats in the treatment cell.

Located on a marsh, the feral cats at Fortescue may be more prone to movement due to changes in climatic conditions than cats in other areas. With the onset of heavy rainfall, it is understandable that they will use terrain away from waterlogged areas. Johnston *et al.* (2013) determined that 2 km was an insufficient buffer for feral cats in dryer habitat within Karijini National Park, Pilbara. The theory behind the addition of a 5 km buffer between the edge of the bait cell and the control monitoring sites appears justified, especially if the movement of feral cats is in fact heavily influenced by rainfall events. It could be argued that a 5 km buffer is insufficient to deal with the increased movement of feral cats in habitats subject to inundation; however the ability to locate sufficient camera-trap monitoring sites in comparative habitat means that this limitation has to be accepted for this situation. Ideally, monitoring sites within the bait cell should be subject to the same buffer from the edge of the bait cell to minimise the influence of transient individuals.

Radio telemetry failed to provide information on baiting efficacy in 2013, but data retrieved from seven cats provided significant information for assessing habitat usage and home range. Using GPS location data recorded every hour, it was determined that the collared feral cats travelled on average 4317.9 ± 2370.7 m (av ± sd) per day, with an average home range of 21.07 ± 9.57 km^2 (mean ± sd). The pattern of movement throughout an average 24 hour period produced a bimodal distribution with the main peak occurring immediately following sunset (i.e. approximately 18:00 h) and a smaller peak around sunrise and the hours immediately following (i.e. approximately 06:00 h). This is likely to reflect the activity patterns of preferred prey species (i.e. small mammals), presumably house mice, especially when utilising habitat affected by human presence (i.e. mining activity).

Analysis of diet samples in this study were from individuals captured around the mine site infrastructure and are likely to be different from those cats located in other habitats. Future diet studies could provide further clarity concerning the preferred diet of feral cats in different habitats at Fortescue Marsh. Around the mine-site infrastructure feral cat diet included birds and insects with a single sample containing evidence of house mouse. In contrast, the stomach of a marsh cat contained no insects and contained evidence of house mouse, bird and reptile. This suggests that feral cats on the marsh maintain a more natural diet of small vertebrates, whereas cats in the vicinity of human habitation/infrastructure may subsist on less nutritious prey (e.g. insects) between scavenging from humans.

Although the quality of the data provided by the collars was reasonable, the reliability of the collars again proved to be questionable. It appears as though two collars fell from the cats due to poor workmanship only days after being attached, whilst another two remained on the cats but recorded less than one week of data. This resulted in home range data only available from three individuals. It is recommended that an alternative supplier be considered for future studies.

Remote camera-trap surveys failed to identify any threatened mammal species, although incidental records of Bilby activity were observed during the establishment of survey sites. Further investigation is required to determine the extent of their habitat and occupancy in this and other areas that are no longer managed as active pastoral land, but this is beyond the scope of the current project. Bilby populations have displayed a favourable response to feral cat baiting in other semi-arid areas (i.e. Lorna Glen) and are not considered to be at risk of consuming the bait.
Again, there were no Northern Quolls (*Dasyurus hallucatus***)** identified on camera and suitable habitat for this species has yet to be found at or adjacent to the study sites.

A significant number of raptors were captured during the targeted feral cat trapping at the marsh (*n*=13 individuals). Species included Barn Owl (*n*=7), Brown Goshawk (*n*=3), Brown Falcon (*n*=2) and Collared Sparrowhawk (*n*=1). Such high numbers of raptors may be influenced by an abundance of house mice usually associated with presence of humans.

There was a considerable number of cattle records from camera-traps located on the marsh particularly within the bait cell and the second control area in the north-east of the marsh. The area to the east of the marsh is subject to considerable pastoral activity and, although vegetation on the marsh is not considered by pastoralists to be favourable for grazing, stray cattle appear to be fairly common in these areas. At the very least, cattle are present in all areas immediately adjacent to the marsh in the north-east, east and south east. Unfortunately this reduces the value of the areas west of the bait cell as a control site as active pastoral activity has been significantly reduced and the quality of habitat for native species consequently appears to be greater.

From the preliminary analysis of the data acquired during the targeted bird surveys, it appears as though both survey methods provide a similar level of results for the effort required. Currently, the analysis of large volumes of ARU data (i.e. 822 hours in this study) is a highly time-expensive exercise, compared with distance estimation surveys. However, in order to produce a sufficiently large dataset, ARUs remain the most cost and time-efficient method of data collection. In addition, refining the techniques involved in data analysis (e.g. with computer software) will potentially allow sizeable datasets to be analysed in a relative short period of time in the future.

4.1 Recommendations

Recommendations for 2014 will be discussed with the Fortescue Marsh Working Group and FMG staff. However as a preliminary, the below are suggestions for the 2014 program.

- The delivery of baits should be conducted no later than the last week June/first week of July each year, and remain flexible based on prevailing weather conditions.
- The use of remote cameras has proved invaluable, and in 2014 this will be repeated with a control area maintained.
- Feral cats will be radio-collared to increase information on efficacy of baiting and habitat use, with efforts made to target animals occupying habitat further away from existing infrastructure.

5 Acknowledgements

The authors would like to acknowledge Neil Hamilton and Jason Fletcher who supported field work for the program. Allan Burbidge assisted with bird surveys and provided valuable comments on bird data and an earlier draft of this report. Hamish Robertson provided support in the Pilbara Region. Thanks to Rob Brazell, Shane Morse and Robin Wilcockson, for preparation and delivery of baits. Tony Raudino and Ash Millar from Western Shield provided logistical support for bait delivery. Butch Mayer assisted with aerial radio tracking of feral cats. We also thank Fortescue Metals Group for providing funds for this work, staff at Christmas Creek and Cloudbreak and Cath Bozanich for her assistance to the IFRP team.

6 References

Abbott I (2002) Origin and spread of the cat, Felis catus, on mainland Australia, with a discussion of the magnitude of its early impact on native fauna. Wildlife Research. 29, 51-74.

Algar D & Burrows ND (2004) A review of Western Shield: feral cat control research. *Conservation Science Western Australia* **5(**2), 131-163.

Algar D, Angus GJ, Williams MR, *et al*. (2007) Influence of bait type, weather and prey abundance on bait uptake by feral cats (*Felis catus*) on Peron Peninsula, Western Australia. *Conservation Science Western Australia* **6**(1), 109-149.

Algar D, Onus ML, & Hamilton NA (in press 2013). Feral cat control as part of 'Rangeland Restoration' at Lorna Glen (Matuwa), Western Australia – the first seven years.. *Conservation Science Western Australia.*

Bibby CJ, Burgess ND, Hill DA & Mustoe SH (2000) *Bird Census Techniques* (2^{nd} Edition). Elsevier, London, UK.

Blyth J (1996) Night Parrot (*Pezoporus occidentalis*) Interim Recovery Plan for Western Australia 1996 to 1998 [Online] TSCU, WA CALM. Available from: <http://www.dec.wa.gov.au/pdf/plants_animals/threatened_species/irps/fauna/pez_occ_irp4.pdf> (Accessed 6/09/2013).

Boitani, L. & Powell, R.A. (2012). Carnivore Ecology: A handbook of techniques. Oxford University Press, London.

Burbidge AA & McKenzie NL (1989) Patterns in the modern decline of Western Australia's vertebrate fauna: causes and conservation implications. *Biological Conservation* **50**, 143-198.

Bureau of Meterology Website < http://www.bom.gov.au/climate/data/> (Accessed 23/10/2013).

Burt JM (2001) Syrinx. Ithaca, New York: Bioacoustics Research Program, Cornell Laboratory of Ornithology. <http://www.syrinxpc.com>.

Christensen PES & Burrows ND (1995) Project Desert Dreaming: the reintroduction of mammals to the Gibson Desert. In *Reintroduction Biology of Australian and New Zealand Fauna* (ed. M Serena), pp. 199-208. Surrey Beatty and Sons, Chipping Norton.

Comer S, Burbidge A, Algar D, Berryman A & Bondin A (2013 in press). Kyloring, cats and conservation: the race to save the western ground parrot. LANDSCOPE, December 2013.

DEWHA (Department of the Environment, Heritage, Water and the Arts) (2008a) Threat Abatement Plan for Predation by Feral Cats, DEWHA, Canberra.

DEWHA (Department of the Environment, Heritage, Water and the Arts) (2008b) Australian Heritage Database. *Fortescue Marshes, Roy Hill, WA, Australia*. Department of the Environment, Heritage, Water and the Arts. Australian Federal Government.

Dickman CR (1996a) Impact of exotic generalist predators on the native fauna of Australia. *Wildlife Biology* **2**, 185-195.

Dickman CR (1996b) *Overview of the Impact of Feral Cats on Australian Native Fauna*. Report to Australian Nature Conservation Agency.

EA (1999) *Threat Abatement Plan for Predation by Feral Cats*. Environment Australia, Biodiversity Group, Canberra, Australia.

EA (2001) *A Directory of Important Wetlands in Australia*, Third Edition. Environment Australia, Canberra.

Fischer J & Lindenmayer DB (2000) An assessment of the published results of animal relocations. *Biological Conservation* **96**(**1**), 1-11.

Fortescue (2009) *Fortescue Marshes Management Plan*. Fortescue Metals Group Limited.

Gibson DF, Johnson KA, Langford DG, *et al*. (1995) The Rufous Hare-wallaby *Lagorchestes hirsutus*: a history of experimental reintroduction in the Tanami Desert, Northern Territory. In *Reintroduction Biology of Australian and New Zealand Fauna* (ed. M Serena), pp 171-176. Surrey Beatty and Sons, Chipping Norton.

Hurni H (1981) Daylength and breeding in the domestic cat. *Laboratory Animals* **15**, 229-233/.

Johnson KA, Burbidge AA & McKenzie NL (1989) Australian Macropodoidea: status, causes of decline and future research and management. In *Kangaroos, Wallabies and Rat Kangaroos* (eds. G Grigg, P Jarman & I Hume) Surrey Beatty, Sydney.

MacKenzie DI, Nichols JD, Royle *et al.* (2006) Occupancy *Estimation and Modelling: Inferring Patterns and Dynamics of Species Occurrence.* Elsevier, New York.

Mattiske Consulting Services (2005) Flora and vegetation on the Cloud Break and White Knight Leases. Report for the Fortescue Metals Group.

McKenzie NL, Burbidge AA, Baynes A, *et al*. (2007) Analysis of the factors implicated in the recent decline of Australia's mammal fauna. *Journal of Biogeography* **34**, 597-611.

McKenzie NL., van Leeuwen S, & Pinder AM (2009) Introduction to the Pilbara Biodiversity Survey, 2002 - 2007. *Records of the Western Australian Museum* **Supplement No. 78**, 3-89.

Morton SR (1990) The impact of European settlement on the vertebrate animals of arid Australia: a conceptual model. *Proceedings of the Ecological Society of Australia* **16**, 201-213.

O'Brien TG, Kinnaird MF. & Wibisono HT (2011) Estimation of species richness of large vertebrates using camera traps: an example from an Indonesian rainforest. In *Camera Traps in Animal Ecology: Methods and Analyses* (eds. AF O'Connell *et al*.) pp 233-252. Springer.

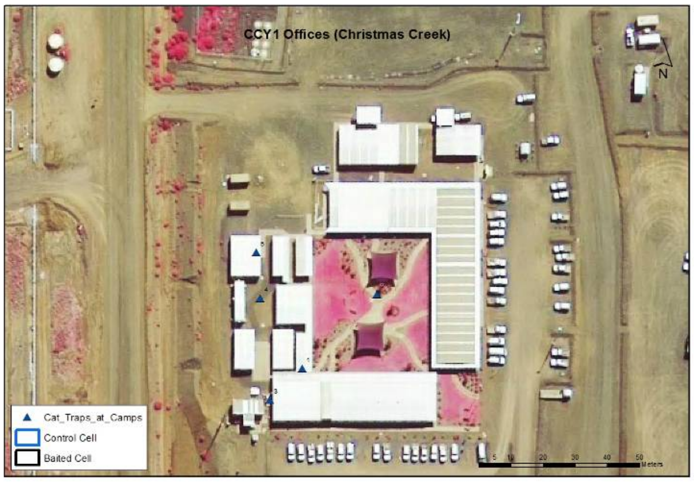
Risbey DA, Calver M, Short J, *et al*. (2000) The impact of cats and foxes on the small vertebrate fauna of Heirisson Prong, Western Australia. II. A field experiment. *Wildlife Research* **27**, 223-235.

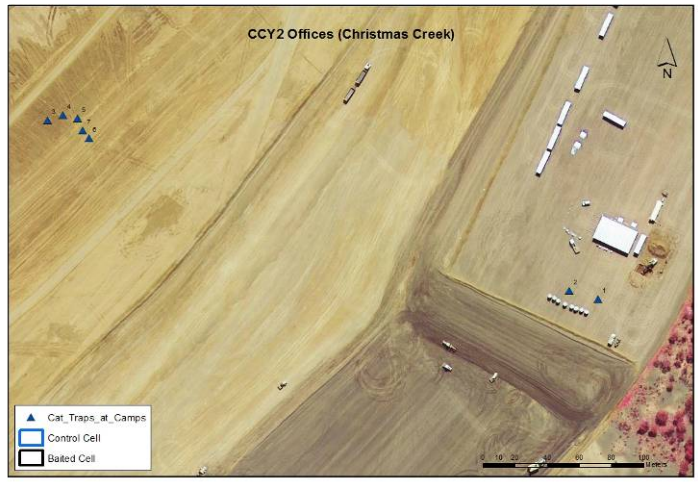
Short J, Turner B, Risbey DA, *et al*. (1997) Control of feral cats for nature conservation. II. Population reduction by poisoning. *Wildlife Research* **24**, 703-714.

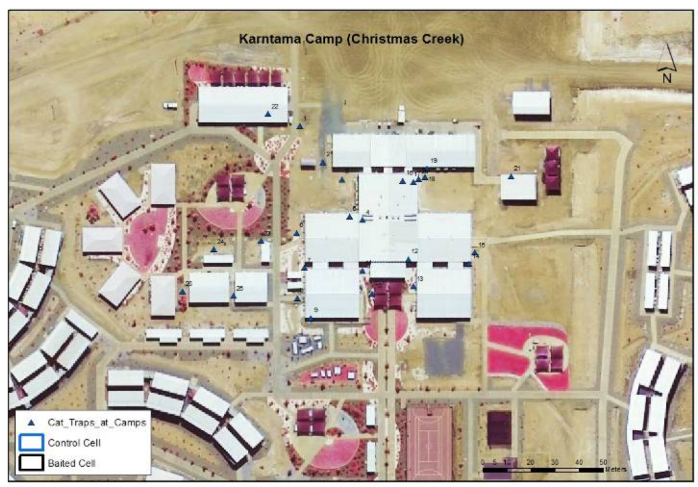
Smith AP & Quin DG (1996) Patterns and causes of extinction and decline in Australian conilurine rodents. Biological Conservation 77, 243 - 267

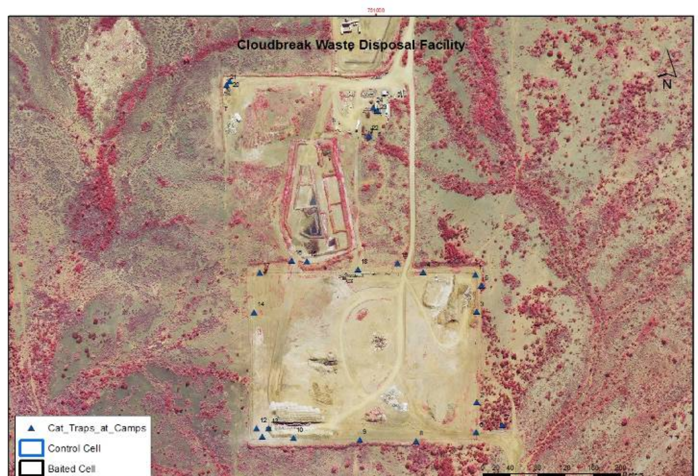
7 Appendices

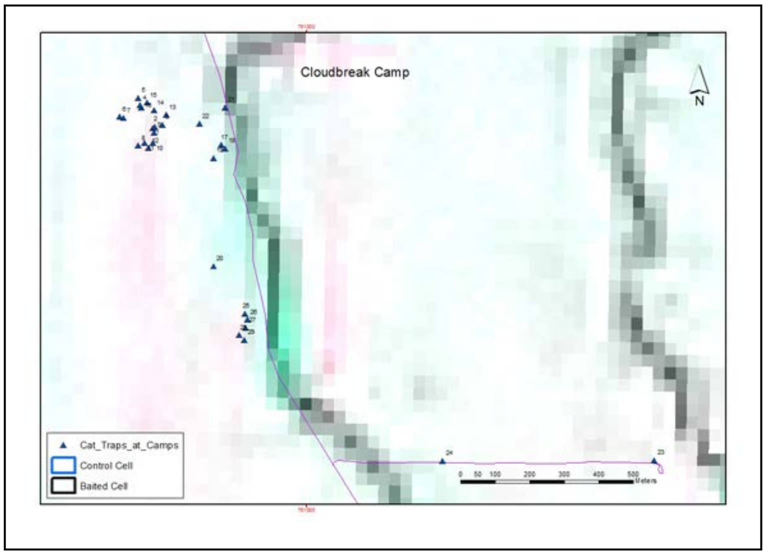
Appendix A. Feral cat trap placement around mine-related infrastructure










Cloudbreak Camp
N
Cat_Traps_at_Camps
Control Cell
Baited Cell
0 50 100 200 300 400 500 Meters

Appendix B. 2012 and 2013 bird species list for Fortescue Marsh

Species	Scientific Name	DPaW Schedule	2012					2013					
			Calls Recorded	Camera (2012)	4/7/12 - 15/7/12	7/8/12 - 12/8/12	31/8/12 - 15/9/12	Camera (2013)	ARU (2013)	18/5/13 - 31/5/13	16/6/13 - 23/6/13	15/7/13 - 20/7/13	16/8/13 - 27/8/13
Emu	*Dromaius novahollandiae*				B	B	B	Y			B		
Stubble Quail	*Coturnix pectoralis*			Y									
Brown Quail	*Coturnix ypsilophora*			Y		B		Y					
Plumed Whistling-duck	*Dendrocygna eytoni*	*			A					B		B	B
Australian Shelduck	*Tadorna tadornoides*	*	Y			A					B		
Grey Teal	*Anas gracilis*	*					A			B	B	B	B
Pacific Black Duck	*Anas superciliosa*	*				A							A
Pink-eared Duck	*Malacorhynchus membranaceus*	*								A	B	B	
Australasian Grebe	*Tachybaptus novaehollandiae*											A	A
Common Bronzewing	*Phaps chalcoptera*			Y	A	A	Y	Y			B	B	
Spinifex Pigeon	*Geophaps plumifera*									A			B
Crested Pigeon	*Ocyphaps lophotes*		Y	Y	Y	Y	Y		Y	Y	Y	Y	B
Diamond Dove	*Geopelia cuneata*		Y	Y	Y	Y	Y	Y		Y	Y	Y	B
Peaceful Dove	*Geopelia striata*		Y			A							
Tawny Frogmouth	*Podargus strigoides*			Y		B							
Spotted Nightjar	*Eurostopodus argus*				A								
Australian Owlet-nightjar	*Aegotheles cristatus*							Y					
Australian Darter	*Anhinga novaehollandiae*					A				B			
Little Black Cormorant	*Phalacrocorax sulcirostris*					A							
Australian Pelican	*Pelecanus conspicillatus*					A							
White-necked Heron	*Ardea pacifica*					A				B	B		
Eastern Great Egret	*Ardea modesta*	3*				C							

Species	Scientific Name	DPaW Schedule	**2012**					**2013**					
			Calls Recorded	Camera (2012)	4/7/12 - 15/7/12	7/8/12 - 12/8/12	31/8/12 - 15/9/12	Camera (2013)	ARU (2013)	18/5/13 - 31/5/13	16/6/13 - 23/6/13	15/7/13 - 20/7/13	16/8/13 - 27/8/13
White-faced Heron	*Egretta novaehollandiae*					C				B			
Straw-necked Ibis	*Threskiornis spinicollis*		Y			C	B			B			B
Royal Spoonbill	*Platalea regia*					A	A						
Yellow-billed Spoonbill	*Platalea flavipes*					A							
Black-shouldered Kite	*Elanus axillaris*	*			B	C	C			B	B		B
Black-breasted Buzzard	*Hamirostra melanosternon*	*				B					Y		
White-bellied Sea-eagle	*Haliaeetus leucogaster*	3*					A						
Whistling Kite	*Haliastur sphenurus*	*	Y	Y	Y	Y	Y			Y	Y	B	B
Black Kite	*Milvus migrans*	*			A	B	A			A	A	B	B
Brown Goshawk	*Accipiter fasciatus*	*		Y	B	Y	B	Y		B	Y	B	
Collared Sparrowhawk	*Accipiter cirrocephalus*	*		Y		A	B			B			
Spotted Harrier	*Circus assimilis*	*			Y	Y	Y			Y	B	B	B
Swamp Harrier	*Circus approximans*			?									
Wedge-tailed Eagle	*Aquila audax*	*		Y	B	A	B			Y	B		B
Little Eagle	*Hieraaetus morphnoides*	*			B	A	B				B		
Nankeen Kestrel	*Falco cenchroides*	*		Y	Y	Y	Y	Y		Y	Y	Y	B
Brown Falcon	*Falco berigora*	*		Y	Y	Y	Y			Y	Y	B	B
Australian Hobby	Falco longipennis	*			B	C	A			B	B		
Grey Falcon	*Falco hypoleucos*	1*											A
Black Falcon	*Falco subniger*	*			A	C	A			B	B		
Black-tailed Native-hen	*Tribonyx ventralis*										B	B	B
Australian Bustard	*Ardeotis australis*	P4		Y	Y	Y	Y	Y		Y	B	B	
Black-winged Stilt	*Himantopus himantopus*	*				A							B

Species	Scientific Name	DPaW Schedule	2012					2013					
			Calls Recorded	Camera (2012)	4/7/12 - 15/7/12	7/8/12 - 12/8/12	31/8/12 - 15/9/12	Camera (2013)	ARU (2013)	18/5/13 - 31/5/13	16/6/13 - 23/6/13	15/7/13 - 20/7/13	16/8/13 - 27/8/13
Red-capped Plover	*Charadrius ruficapillus*	*				C							
Oriental Plover	*Charadrius veredus*	3*					B						
Inland Dotterel	*Charadrius australis*	*		Y	C	Y							
Red-kneed Dotterel	*Erythrogonys cinctus*	*								B	B	B	B
Black-fronted Dotterel	*Elseyornis melanops*	*			C	A	A			B	B	B	A
Red-necked Stint	*Calidris ruficollis*	3*				C							
Little Button-quail	*Turnix velox*			Y	Y	Y	Y	Y		B	Y		
Australian Pratincole	*Stiltia isabella*					B			Y		B		
Galah	*Eolophus roseicapillus*		Y	Y	Y	Y	Y	Y		Y	Y	Y	B
Little Corella	*Cacatua sanguinea*				B	B	Y			B	B	B	B
Cockatiel	*Nymphicus hollandicus*		Y	Y	Y	Y	Y		Y	B	B	B	B
Australian Ringneck	*Barnardius zonarius*		Y			B			Y	B	B	B	A
Budgerigar	*Melopsittacus undulatus*		Y	Y	Y	Y	Y		Y	Y	Y	B	B
Bourke's Parrot	*Neopsephotus bourkii*			Y						Y	Y	B	A
Elegant Parrot	*Neophema elegans*									B	B	B	
Horsfield's Bronze-cuckoo	*Chalcites basalis*								Y		B		
Pallid Cuckoo	*Cacomantis pallidus*									A			
Southern Boobook	*Ninox novaeseelandiae*			Y			A						
Eastern Barn Owl	*Tyto javanica*									B			
Blue-winged Kookaburra	*Dacelo leachii*					A							
Red-backed Kingfisher	*Todiramphus pyrrhopygius*				Y	B	A			B	B		B
Sacred Kingfisher	*Todiramphus sanctus*					A							
Rainbow Bee-eater	*Merops ornatus*	3*	Y		B	A	B			Y	B	B	B

Species	Scientific Name	DPaW Schedule	2012					2013					
			Calls Recorded	Camera (2012)	4/7/12 - 15/7/12	7/8/12 - 12/8/12	31/8/12 - 15/9/12	Camera (2013)	ARU (2013)	18/5/13 - 31/5/13	16/6/13 - 23/6/13	15/7/13 - 20/7/13	16/8/13 - 27/8/13
Western Bowerbird	*Ptilonorhynchus guttatus*			Y				Y		B	A		
White-winged Fairy-wren	*Malurus leucopterus*		Y	Y	Y	Y	Y	Y	Y	Y	Y	B	B
Variegated Fairy-wren	*Malurus lamberti*		Y		C	Y	Y		Y	Y	B		A
Redthroat	*Pyrrholaemus brunneus*		Y			B					B		
Weebill	*Smicrornis brevirostris*		Y		B	C				B	Y		
Western Gerygone	*Gerygone fusca*										B		
Chestnut-rumped Thornbill	*Acanthiza uropygialis*								Y		B	B	B
Slaty-backed Thornbill	*Acanthiza robustirostris*		Y		Y	Y	Y			Y	B		
Inland Thornbill	*Acanthiza apicalis*										B		
Red-browed Pardalote	*Pardalotus rubricatus*				B	B	A			A	B		
Pied Honeyeater	*Certhionyx variegatus*		Y		?B				Y		B	B	
Singing Honeyeater	*Lichenostomus virescens*		Y	Y	Y	Y	Y	Y	Y	Y	Y	B	
Grey-headed Honeyeater	*Lichenostomus keartlandi*						A			A	B		A
White-plumed Honeyeater	*Lichenostomus penicillatus*		Y		B	B	A		Y	Y	B		B
White-fronted Honeyeater	*Purnella albifrons*								Y		C		
Yellow-throated Miner	*Manorina flavigula*		Y	Y	B	Y	Y			Y	B		B
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*		Y		Y	Y	Y		Y	B	B	Y	B
Grey Honeyeater	*Conopophila whitei*				?B						?B		
Crimson Chat	*Epthianura tricolor*		Y	Y	Y	Y	Y	Y	Y	Y	Y	B	B
Orange Chat	*Epthianura aurifrons*					C					B	B	
Black Honeyeater	*Sugomel niger*		Y		B	B			Y		B	B	
Brown Honeyeater	*Lichmera indistincta*		Y		B	B	B				Y		

Species	Scientific Name	DPaW Schedule	2012					2013					
			Calls Recorded	Camera (2012)	4/7/12 - 15/7/12	7/8/12 - 12/8/12	31/8/12 - 15/9/12	Camera (2013)	ARU (2013)	18/5/13 - 31/5/13	16/6/13 - 23/6/13	15/7/13 - 20/7/13	16/8/13 - 27/8/13
Black-chinned Honeyeater	*Melithreptus gularis*										?B		
Grey-crowned Babbler	*Pomatostomus temporalis*		Y			A	Y		Y	B	A	B	
White-browed Babbler	*Pomatostomus superciliosus*			Y	C	C				B	B		
Chestnut-breasted Quail-thrush	*Cinclosoma castaneothorax*										B		
Ground Cuckoo-shrike	*Coracina maxima*			Y		C							
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		Y		Y	Y	Y			B	B		B
White-winged Triller	*Lalage sueurii*				Y	Y	Y			B	B	B	B
Rufous Whistler	*Pachycephala rufiventris*		Y		Y	Y	Y		Y	B	B	B	B
Crested Bellbird	*Oreoica gutturalis*		Y	Y	Y	Y	Y		Y	Y	Y	B	B
Masked Woodswallow	*Artamus personatus*		Y			B	Y		Y	Y	Y	B	B
Black-faced Woodswallow	*Artamus cinereus*		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	B
Grey Butcherbird	*Cracticus torquatus*										B	B	
Pied Butcherbird	*Cracticus nigrogularis*		Y	Y	Y	Y	Y		Y	B	Y	B	A
Australian Magpie	*Gymnorhina tibicen*			Y	B	B	A						
Willie Wagtail	*Rhipidura leucophrys*		Y	Y	Y	Y	Y	Y	Y	Y	Y	B	B
Little Crow	*Corvus bennetti*			?	B	B	A				B		
Torresian Crow	*Corvus orru*		Y	Y	Y	Y	Y	Y	Y	Y	Y	B	B
Magpie-Lark	*Grallina cyanoleuca*		Y	Y	B	B	Y		Y	Y	Y	B	B
Red-capped Robin	*Petroica goodenovii*		Y	Y	B	Y	B			B	B		B
Hooded Robin	*Melanodryas cucullata*			Y	B					B	B		
Horsfield's Bushlark	*Mirafra javanica*			Y	Y	Y	Y		Y	Y	Y	B	
Rufous Songlark	*Cincloramphus mathewsi*			Y	Y	Y	B			B	B	B	B

Species	Scientific Name	DPaW Schedule	2012					2013					
			Calls Recorded	Camera (2012)	4/7/12 - 15/7/12	7/8/12 - 12/8/12	31/8/12 - 15/9/12	Camera (2013)	ARU (2013)	18/5/13 - 31/5/13	16/6/13 - 23/6/13	15/7/13 - 20/7/13	16/8/13 - 27/8/13
Brown Songlark	*Cincloramphus cruralis*			Y		Y	Y	Y	Y	Y	B	B	
Spinifexbird	*Eremiornis carteri*		Y		B	Y	B		Y	Y	A		B
Fairy Martin	*Petrochelidon ariel*					A	C						B
Tree Martin	*Petrochelidon nigricans*										B		
Mistletoebird	*Dicaeum hirundinaceum*										B		
Zebra Finch	*Taeniopygia guttata*		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Painted Finch	*Emblema pictum*												A
Australasian Pipit	*Anthus novaeseelandiae*			Y	Y	Y	Y	Y	Y	Y	Y	B	

A Adjacent to either B or C but presumed that species may use study area (Note: B or C overrides A in Table)
B Bait cell only
C Control only
Y Both B and C
? Possible sighting (not definite)

1 Included under Schedule 1 of WA Wildlife Conservation Act (1950) (updated November 2012)
3 Included under Schedule 3 of WA Wildlife Conservation Act (1950) (updated November 2012)
* Included under EPBC Migratory Species List (JAMBA/CAMBA/Bonn Convention)
P4 Priority 4 under WA Wildlife Conservation Act (1950)

Appendix C. Table of results of feral cats recorded on camera-trap surveys

	Treatment		Control 1		Control 2		Controls Combined		Buffer	
	Pre-bait	Post-bait	Pre-bait	Post-bait	Pre-bait	Post-bait	Pre-bait	Post-bait	Pre-bait	Post-bait
No. cameras with cats[1]	8	4	3	8	0	4	3	12	2	0
No. events[2]	12	4	3	11	0	5	3	16	5	0
Estimated no. individuals[3]	10	4	3	10	0	5	3	15	2	0

[1] Number of cameras with cats recorded on them during a monitoring period

[2] Number of individual events, with a discrete event defined as a visit to a camera site occurring more than 60 minutes since the last visitation by the same animal

[3] Number of individuals recorded based on discrimination between individual cats using coat pattern and colour