REPORT ON STAGES 2 and 3 OF THE 'CHRISTMAS ISLAND CAT AND BLACK RAT MANAGEMENT PLAN'

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REPORT OUTLINE

The purpose of this program was to continue Stages 2 and 3 of the 'Christmas Island Cat and Rat Management Plan' (Algar and Johnston 2010). Stage 1 of the Management Plan which involved de-sexing, micro-chipping and registration of all domestic (owned) cats on the island was continued with the annual domestic cat survey being conducted in May 2017. Documentation and results of this survey are provided in an additional report (Algar 2017).

The primary aim of Stage 2 of the plan was to remove all stray cats within the residential, commercial and light industrial zones of Christmas Island. This also included cats at the Immigration Detention Centre (IDC) at North West Point (NWP). Without implementation of Stage 2 a significant source of cats, particularly natal recruits, would be available to disperse into or reinvade territories vacated across the rest of the island (i.e. the national park and Unallocated Crown Land). Stage 2 was required before an island-wide control program (Stage 3) could be implemented. Stage 2 is an ongoing requirement and is to be continued until cat eradication has been successfully completed.

Stage 3 commenced in 2015 and has continued this year. The program involves island-wide removal of feral cats through baiting, trapping and opportunistic shooting. Monitoring the outcome of this control effort is undertaken by Parks Australia. In this report we document control effort for each of these activities.

BACKGROUND

There is extensive evidence that the introduction of domestic cats (*Felis catus*), to both offshore and oceanic islands around the world can have deleterious impacts on endemic land vertebrates and breeding bird populations (see Ratcliffe *et al*. 2009; Bonnaud *et al*. 2010). Feral cats have been known to drive numerous extinctions of endemic species on islands and have contributed to at least 14% of all 238 vertebrate extinctions recorded globally by the IUCN (Nogales *et al*. 2013). In addition, predation by feral cats currently threatens 8% of the 464 species listed as critically endangered (Medina *et al*. 2011; Nogales *et al*. 2013). Island faunas that have evolved for long periods in the absence of predators are particularly susceptible to cat predation (Dickman 1992). Christmas Island—a high biodiversity island—is no exception.

Four of the five mammal species that were present on the island at settlement in 1888 have since become extinct. The diurnal native bulldog rat (*Rattus nativitatus*), for example, was reportedly common at the time of settlement; while the nocturnal Maclear's rat (*R. macleari*) was extremely abundant. The Christmas Island shrew (*Crocidura attenuata trichura*) has not been seen since 1985 and is believed extinct and, most recently, the Christmas Island pipistrelle (*Pipistrellus murrayi*) is thought to have become extinct in 2009 (Martin *et al*. 2012). While several factors are likely to have contributed to the demise of these native animals including disease, habitat destruction (land clearing and natural catastrophes such as cyclones) and the proliferation of the exotic yellow crazy ant (*Anoplolepsis gracilipes*), the introduction of exotic competitors and predators such as the cat and black rat (*R. rattus*) are also crucial factors.

In addition, several extant Christmas Island species are listed as being species likely to be adversely affected by cats and/or rats. These include the endemic Christmas Island emerald dove (*Chalcophaps indica natalis*) (listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as 'Endangered') and the red-tailed tropicbird (*Phaethon rubricauda*) (an EPBC listed marine species). In 2014, the EPBC listing of the white-tailed tropicbird (*P. lepturus*) was upgraded from 'Threatened' to 'Endangered'. The forest skink (*Emoia nativitatis*) and blue-tailed skink (*Cryptoblepharus egeriae*) were listed as 'Critically Endangered' in early 2014. Lister's gecko (*Lepidodactylus listeri*) was upgraded to 'Critically Endangered' from 'Vulnerable' in early 2014 and the giant gecko (*Cyrtodactylus sadleiri*) listed as 'Endangered'.

This impact of cats in particular, and also rats on the biodiversity of Christmas Island was of significant concern to land management agencies and the broader community. As a consequence, a 'Management Plan for Cats and Black Rats on Christmas Island' (see Algar and Johnston 2010) was commissioned that would mitigate the environmental and social impacts of cats and black rats across all land tenures (shire-managed lands, Crown land including mine leases and Christmas Island National Park). A strategy was recommended that provided a staged approach to cat management and control leading to eradication. This document reports on the continuation of Stages 2 and 3 [see above Report Outline].

METHODOLOGY

Domestic Cat Survey

The `Management Plan for Cats and Black Rats on Christmas Island' (Algar and Johnston 2010) proposed a strategy to eradicate cats entirely from the island as the de-sexed domestic population died out. This was based on four actions:

1) to register and de-sex all domestic cats;
2) to destroy all non-domestic (i.e. stray and feral) cats;
3) to establish a 'cat prohibited area' along the Settlement shoreline to include the red-tailed tropicbird rookeries; and,
4) to prohibit the importation of new cats.

Cat registration was an essential first stage to two of these outcomes as it would: (i) ensure the release rather than destruction of domestic cats during trapping campaigns for stray and feral cats and (ii) to ensure the de-sexing of all domestic cats, preventing potential natal recruitment into the domestic, stray and feral populations.

To ensure that all domestic cats were registered it was necessary to conduct a survey for domestic cats (Algar *et al*. 2011a), across the entire residential area, before the commencement of the veterinary program. The veterinary program is described in detail in Algar *et al*. (2011b).

Surveys for domestic cats were conducted prior to veterinary programs in October 2010 at the commencement of the cat management program and again in May 2011 (Algar *et al*. 2011b). What was hoped to be the final veterinary program was conducted in May 2012 following the survey that year (Algar *et al*. 2012; Algar *et al*. 2014). Subsequent surveys have been conducted in May 2013 (Algar and Hamilton 2013), 2014 (Algar and Hamilton 2014), 2015 (Parks Australia 2015) and 2016 (Algar *et al*. 2016). In 2016, prior to the domestic cat survey, it came to our attention that a number of unregistered cats were being kept as pets. It was decided by the ''Cat Management Steering Committee'' that a short-term amnesty on pet cat ownership be invoked so that these animals could also be de-sexed and registered. A final veterinary program was endorsed and fines were issued to those residents who wanted their cat to be de-sexed and registered, otherwise unregistered cats could be handed in and destroyed without charge (see Algar *et al*. 2016). Documentation of the domestic cat survey this year is provided in an additional report (see Algar 2017).

Baits and the Baiting Program

The feral cat baits used (*Eradicat*®, see detailed description in Algar and Burrows 2004; Algar *et al*. 2007) were manufactured at the Department of Biodiversity and Attractions' Bait Manufacturing Facility at Harvey, Western Australia. Baits were transported to Christmas Island and then kept in frozen storage. Toxic feral cat baits are dosed at 4.5 mg of sodium monofluoroacetate (compound 1080) per bait. Consistent with previous baiting programs, baits were suspended from 'Bait Station Devices' (BSDs) (see Algar and Brazell 2008).

The baiting program in 2017 adopted recommendations provided in previous reports. Baiting was to be conducted along the island's extensive road and track network. The baiting program commenced in May, with baits to be deployed over five consecutive days along each site. BSDs were visited daily over this period and bait removal recorded. BSDs were located at 100 m intervals on both sides of the road/track, staggered at 50 m intervals across the road/track. A bait, comprising two *Eradicat*® sausages tied at the link, was suspended at a height of about 400 mm from each BSD using 6–8 lb fishing line. Baits were replaced when taken and also routinely as

required if they became mouldy or if phosphate dust raised by passing vehicles adhered to the baits and was considered likely to reduce palatability.

No BSDs were deployed within the 500 m township exclusion buffer, nor along Vagabond Rd/Phosphate Hill Section. All major haul roads, internal forest tracks, designated vegetation rehabilitation tracks and mine lease areas were baited. Main haul roads and open tracks were baited first as these areas experience more sunlight and airflow, allowing the baits to sweat and last longer. Forested areas were baited later in the season as the weather conditions became drier.

As bait station activity cannot be ascribed to individual feral cats, a value for the maximum and minimum number of cats poisoned was determined. The total number of toxic baits removed was considered to indicate the maximum number of individuals poisoned. The minimum number of individuals poisoned was calculated by ascribing bait removals from consecutive BSDs to the same animal, even if ten or more stations were involved. The actual number of feral cats poisoned during these programs would be between these two extremes. It was considered likely that some cats would visit multiple BSDs given the delay between bait consumption and onset of symptoms.

Trapping Program

The registration and de-sexing of domestic cats was the first stage of the management plan (Algar and Johnston 2010), with the second stage—the control of stray and feral cats in the residential, commercial and light industrial area—then able to proceed. Results from the previous cat control programs have defined areas preferred by stray cats which were targeted during the trapping program. In addition, the community continued their unrelenting support for the program and would inform us of areas where stray cats were present which were also targeted. Traps were strategically located within these sites, typically in areas likely to be food sources and thoroughfares.

Cats were captured using medium (55 x 22 x22 cm) and large (70 x 31 x 31 cm) Sheffield wire cage traps with treadle plates (Sheffield Wire Products, Welshpool Western Australia). All traps were covered with a hessian sack or modified plastic phosphate bag to provide shelter and protection

to the captured animals until they could be collected. The traps were usually baited with cooked chicken wings or Kentucky Fried Chicken wings/drumsticks. Baits were treated with the insecticide Coopex® (Bayer Crop Science, Australia), at a concentration of 12.5 g l^{-1} as per the manufacturer's instructions, to maintain the longevity of the bait by deterring insects from consuming or spoiling the bait. The baits were cable-tied to the back of the cage to reduce trap failures by increasing the time animals spent inside a cage, thus increasing the likelihood of activating the treadle mechanism. Baits were replaced as necessary. Following successful trials in late 2016, large cage traps were usually anchored on garbage (wheelie) bins lying on their side with baffles (Sinbins) (see Plate 1) to minimise interference by land crabs. Cage-trapping of stray cats and confiscation of unregistered pets within the township area was also conducted on an *ad hoc* basis by the Christmas Island Shire rangers following reports from local residents. Captured animals were taken to Parks Australia headquarters to check for the presence of a micro-chip, and if absent the cat was destroyed by Parks' staff.

Plate 1. Cage traps were usually anchored on garbage bins lying on their side to minimise entry by crabs.

A systematic island-wide leg-hold trapping program for feral cats was instigated alongside the island's extensive road network including the internal forested tracks. Trap sets were deployed at 250–300 m intervals for ten days. Padded leg-hold traps, Victor 'Soft Catch'® traps No. 3

(Woodstream Corp., Lititz, Pa., U.S.A.) were used, with a mixture of cat faeces and urine, sourced from cats on the island, as the attractant.

Elevated trap platforms (ETPs) were used to minimise capture of robber crabs (*Birgus latro*). Traps were set on top of half cut 200 l steel drums (dimensions 440 mm high, 560 mm diam.) the rim was raised by cable-tying fire hose (ID 20 mm) around the edge to provide a flat level surface to the height of the trap. In areas where robber crabs were particularly abundant and active, the drums were chocked on wood and raised a further 150 mm. Open-ended trap sets were employed, set parallel to the track on the upwind side where the prevailing night wind would distribute the scent attractant across the track. Two traps positioned lengthwise (adjoining levers touching) were located across the centre of the drum and rocks and sticks used as a barrier along the trap sides and to guide the cat over the plate areas. The pan tension was adjusted so that the trap plates fell under their own weight. The trap bed was made so that when lightly covered with sand, the traps were level with the top of the raised drum rim. The traps were secured together by a 1.6 m stainless steel wire rope (3.2 mm diam.), anchored to the drum through an eye-bolt. This enabled captured cats to jump off the drum and seek shelter in adjacent vegetation. Black filter foam (12 mm thickness) was cut and shaped to fit between the jaws beneath the plate to allow any rainfall to drain through the trap. In addition, neoprene insertion rubber (1.5 mm thickness) was cut and shaped to fit between the jaws was placed over each plate to prevent sand from falling into and compacting the trap bed. The trap was then lightly covered with additional sand. The attractant was placed towards the centre of the trap set against the side rock barrier in a shallow depression on a leaf. The attractant was then sprayed with Coopex® to deter insects from removing the material. A typical ETP is shown in Plate 2.

Plate 2. A typical ETP

Trapped feral cats were euthanased by a head-shot from a 0.22 calibre rifle. All animals captured were sexed, weighed and a broad estimation of age (as either kitten, juvenile or adult) was recorded according to their weight as a proxy for age. In addition, the pregnancy status of females was also used to determine whether the animal was an adult. The smallest weight recorded for a female that had recently given birth, at a time when sexually mature females had bred, was 2.0 kg and this was used as the minimum adult weight for female cats (see Algar and Hamilton 2012). The tip of the ear was removed and stored in ethanol for potential future DNA analysis.

Shooting Program

Dedicated night time spotlighting and shooting was conducted using a 4WD vehicle, 12 volt Lightforce hand spotlight and a registered 0.22 calibre firearm (with scope and torch beam). This was conducted outside of the township area, mostly along the main haul roads and open tracks, driving at approximately 50 km h^{-1}. Details of feral cats shot, or sighted but not shot were recorded, as well as distance travelled each night.

RESULTS

Domestic Cat Survey

Documentation of the 2017 domestic cat survey is not discussed further in this report but results are provided in an additional report (Algar 2017).

Baiting Program

In 2017, 2,907 BSDs (see Fig. 1) were deployed across the island (total 14,520 bait-nights), with bait removal being recorded at 96 of these BSDs (3.3 %). In total, baiting removed between 83 (minimum) and 96 (maximum) feral cats this year. The location of these bait takes are also shown in Fig. 1.

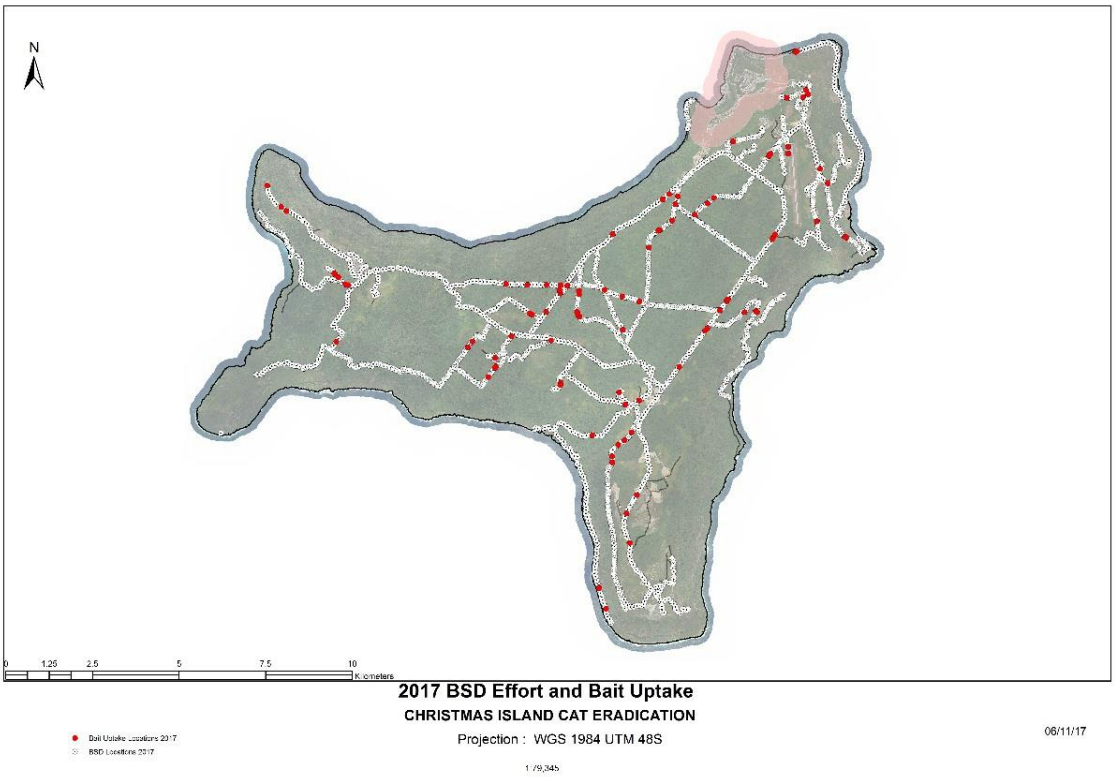

Fig. 1. Location of BSD effort and bait uptake during 2017.

Island-wide forest baiting effort conducted in 2015 and at a much reduced level in 2016 was not continued this year.

Trapping Program

In 2017, approximately 805 cage trap-nights were conducted in the township, commercial and light industrial areas, resulting in the removal of 29 stray cats. The Shire rangers also assisted in targeted and collaborative cage-trapping efforts, deploying both ground and sinbin cages over an estimated 880 cage trap-nights. This has resulted in 14 stray cats trapped and a further two unregistered cats being confiscated by Shire rangers. During cage trapping operations, only two registered pet cats were caught. These were returned to their registered owners. An additional five stray/feral cats have been removed from around the island as recorded roadkill from vehicle traffic. Two cats were removed from the NWP Detention Facility this year by the contracted pest controller. Targeted (ground and sinbin) cage-trapping, together with continued collaboration between local agencies and support from the community has removed a total of 52 stray cats this year. The location of trapping effort and cage-trapped cats is shown in Fig. 2.

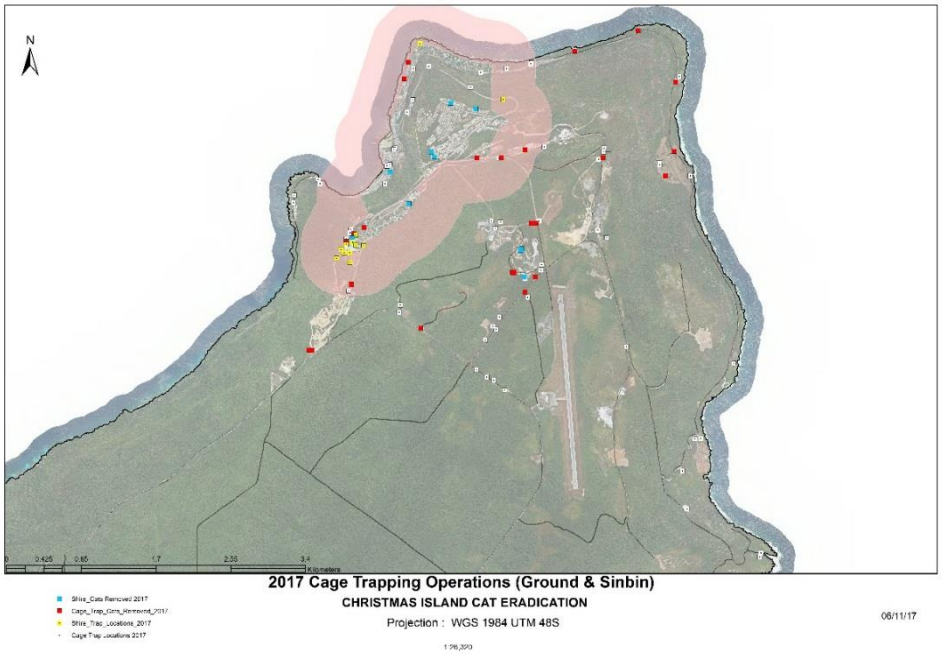

Fig 2. Location of trapping effort and cage-trapped stray cats during 2017.

Five hundred and sixty ETPs were deployed over 5,400 trap-nights. This systematic trapping program resulted in the removal of 85 feral cats. Non-target captures included: 1 x Christmas Island goshawk (*Accipter fasciatus natalis*); 1 x Christmas Island emerald dove ((*Chalcophaps*

indica natalis); 1 x Christmas Island imperial-pigeon (*Ducula whartoni*) and 13 robber crabs, all being released unharmed. The location of deployed ETPs and trapped feral cats is shown in Fig. 3.

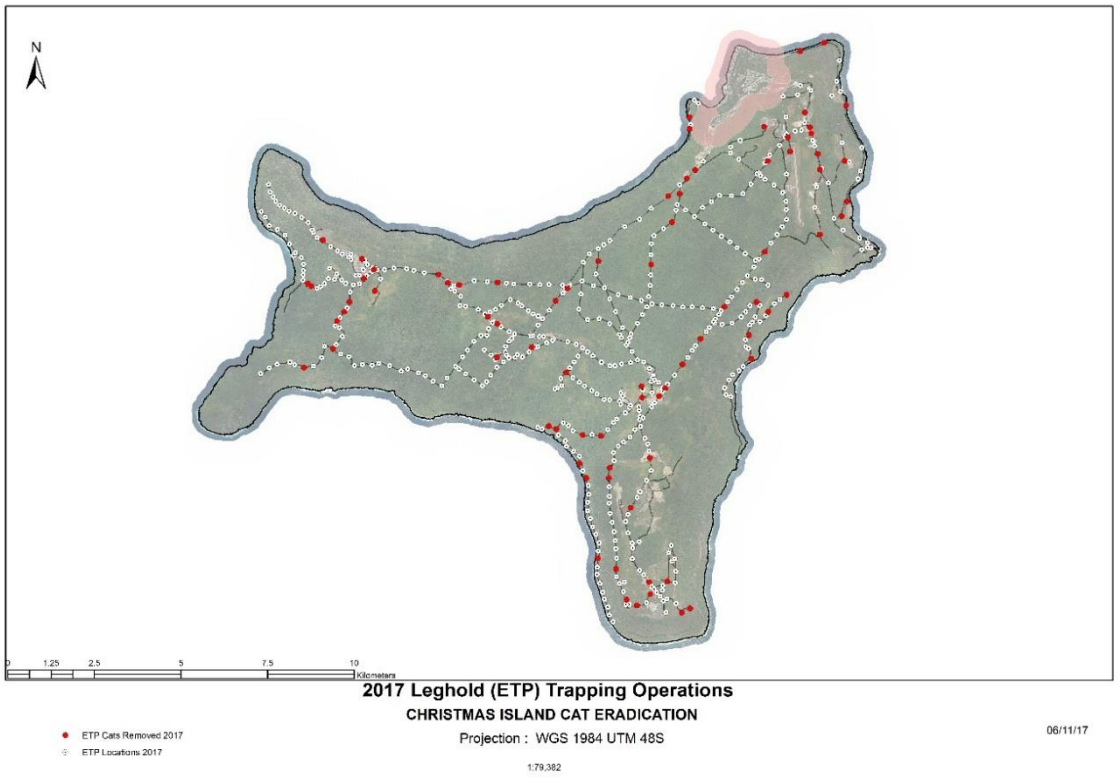

Fig. 3. Location of deployed ETPs and feral cats trapped in 2017.

Shooting Program

In 2017, some 600 km of road and tracks were driven across the island for dedicated spotlighting over a total of ten nights. Firearms were also carried during routine control operations. This resulted in four feral cats being removed, and a further six being sighted. The number of nights spotlighting and distance travelled were limited this year due to intensified trapping and baiting effort which, limited time and staff availability for dedicated search efforts.

DISCUSSION and RECOMMENDATIONS

The return to average and favourable weather conditions this year (compared to 2016) has seen planned island-wide cat control operations being carried out extensively, with significant removal of cat numbers. The drier and persistent conditions this control season has helped improve canopy understorey micro-climates to bait along all of the internal forested tracks (with limited re-baiting). Roadside slashing alongside the island's main haul roads earlier in the season created visibly open areas to deploy BSDs, providing ideal conditions for baiting and trapping. The persistent dry conditions have only taken visible effect since mid-September, maintaining food resource availability for feral cats for longer, which may have contributed to reduced bait uptake earlier in the control season.

The plan to concentrate control efforts along the island's extensive road/track network and prioritise the township and main haul roads first has seen successful implementation of operations and methodology to achieve a significant reduction in the cat population. Continued collaborative control efforts with the Shire rangers and community engagement has seen cat numbers within the township reduced. Ideal and persistent weather conditions towards the latter end of the season has enabled a dry season pilot trial of '*Hisstory'* non-toxic baits to be conducted to inform on future control methods.

Substantial effort went towards intensifying production of the ETPs which, were refined last control season. This has permitted leg-hold traps to be deployed across the island road network following baiting. Firearms use was reduced this year with some opportunistic removals, limited by time prioritised for more efficient control methods. The final round of planned baiting around the township perimeter (repeated from earlier this year) was adapted to a targeted and collaborative trapping campaign with the Shire to efficiently control reported strays within and around this area before the imminent wet season approached.

In summary, control efforts comprised: baiting 145 km of road and track network using over BSDs; combined trapping of over 7,085 trap-nights and spotlighting and shooting for ten nights. Roadside BSDs removed between 83–96 feral cats, cage-trapping removed 43 stray cats, confiscations and vehicles removed nine cats, ETP leg-hold trapping removed 85 and shooting accounted for a further four individuals. In total, these control methods have removed between 224–237 stray/feral cats this season. The location of all stray/feral cats removed during 2017 is shown in Fig. 4. The sex and age structure of the removed population, not including baited individuals, is presented in Table 1. In addition, ten females were pregnant with a total of 26 kittens *in utero* and a further seven were lactating.

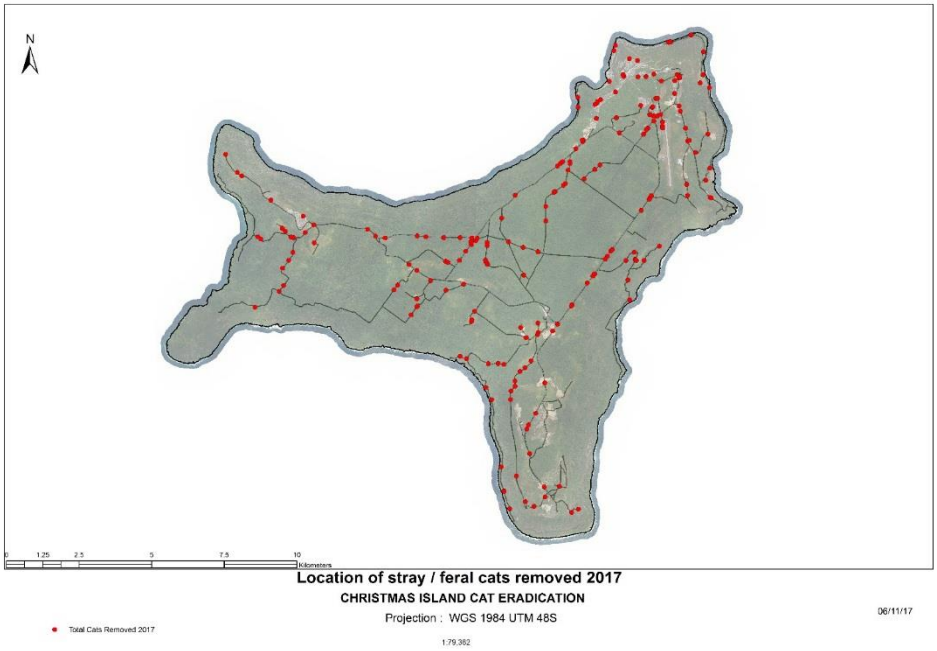

Fig. 4. Location of all stray/feral cats removed following control efforts in 2017.

Table 1. Sex and age classes for all cats removed by methods other than baiting.

Age Class	Female	Male	NA	Total
Kitten	0	6	0	**6**
Juvenile	11	21	0	**32**
Adult	38	64	1*	**103**
Total	**49**	**91**	1	141

* Roadkill, sex could not be determined.

Reports of stray and feral cat sightings by CINP staff, local residents and visitors have assisted in site-specific trapping and provision of records for the observation database maintained by CINP. Increased engagement to gather additional opportunistic sighting information from the community and visitors will be of great value to future operations.

Key Recommendations for 2018

- Maintain observation database and targeted trapping effort within and around the township perimeter in conjunction with Shire rangers throughout the wet season, to control stray cat numbers and protect project investment. This is required to limit incursion of cats from outside of the township and likelihood of natal recruits from becoming illegal pets. Dedicated and opportunistic firearms control will be advantageous during this time in conjunction with other CINP operational activities.

- Continue the road and track network for BSD baiting in the dry season, especially in forested areas to maximise baiting effort and spread across the island. This will require maintaining certain forested tracks including verge vegetation of rehab and mine lease tracks for BSD deployment. This will involve a combined effort and coordination with CINP staff to operate, as well as Shire staff for roadside slashing of main haul roads. Roadside slashing of the township perimeter roadside verges in early April would see BSDs being deployed earlier and systematic control operations beginning in May (rather than June) to help extend duration (and effort) of seasonal control activities. If resources are limited, baiting effort may need to be scaled back to targeted areas, to accommodate roadside and remote trapping effort.

- Continue the extensive roadside trapping program, utilising the same extended road and track network across the island with ETPs. This will involve intensive trapping and shooting by DBCA staff to cover the entire road/track network.

- Refine methodology to undertake remote deployment of modified ETPs away from the roadside network, to isolated areas of the island where access (and previous control effort) is limited.

- Pursue further '*Hisstory'* blank trials and pending outcomes, seek EPBC referral and authority by DIRD to aerially bait targeted areas of the island using a chartered plane/drone in the later part (September) of 2018.

- Continue outsourcing analysis of island-wide monitoring array data (repeated in late 2018) to independent expert statisticians for cat occupancy/population monitoring. This helps free-up a significant amount of staff time to concentrate on extensive control efforts, whilst providing prompt impartial information for seasonal decision making.

- Conduct pre-control season spotlighting survey in April (only once a year, instead of twice) to inform on relative cat activity along the island's road network and targeted control efforts. This will also be comparable to previous years' activity data.

- Continue to conduct the annual domestic pet cat survey in May. This could coincide with a community awareness update of the project. Investigating illegal pet ownership and targeted cage trapping in the township area for stray cats would also be conducted by the Shire.

- Further research into monitoring/surveillance techniques that will compliment camera trapping. This includes continuing work on oestradiol-mediated 'Sentinel cats' and *Acalypha indica* attractants.

- Increase community engagement and participation for stray and feral cat sightings (citizen science) that will inform on targeted control, maintain support and awareness of the project.

- Pending the closure of the NWP Detention Centre next June (2018), remove all stray cats within the fenced facility once clients have left.

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