Government of **Western Australia**

REPORT ON STAGE 2 OF THE 'CHRISTMAS ISLAND CAT AND BLACK RAT MANAGEMENT PLAN'

Prepared by

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REPORT OUTLINE

The purpose of this project was to implement Stage 2B of the 'Christmas Island Cat and Rat Management Plan' (Algar and Johnston 2010). Drafting the Management Plan was funded by the (then) Attorney Generals Department (now DRARDLG) in 2009/10. Following acceptance of the suggested revisions to the current local cat management laws (*Shire of Christmas Island Local Law for the Keeping and Control of Cats 2004*) under the Local Government Act 1995 (WA) (Ci) Stage 1 of the Management Plan which involved de-sexing, micro-chipping and registration of all domestic (owned) cats on the island commenced in late 2010 and the final program was conducted in May 2012.

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), both at North West Point (NWP) and Phosphate Hill precinct. 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). Rat management was also incorporated into Stage 2. Stage 2 was required before an island wide control program (Stage 3) could be implemented. Stage 2 was divided into Stage 2(a) and (b):

Stage 2(a) - Occurred in May to June 2011 funded by Parks Australia which included a contract with the Western Australian Department of Environment and Conservation (WADEC).

Stage 2(b) — commenced implementation from 1 July 2011 and was to be completed by the end of the 2011/12 financial year. This Stage formed the basis of the funding received from DRARDLG. Unfortunately the funding application for commencement of Stage 3, sent to the Commonwealth (Caring for our Country, DSEWPaC) was not granted. Following this decision, at a meeting of the various agencies involved, it was decided that it was imperative that Stage 2(b) should also include an intensive baiting program outward from the residential area. This would remove the majority of individual animals adjacent to the residential area and provide a buffer zone into which dispersing cats would move. This control effort would to a large extent protect the significant

investment and gains achieved in controlling stray cats until a new source of funding could be obtained the following financial year.

The scope of works over the Stage 2(b) period therefore focused on: -

- continued removal of stray/feral cats in the residential, commercial and light industrial area that particularly focused on the landfill site;
- continued removal of stray/feral cats at the Red-tailed Tropicbird rookeries located at the Sifting Room and Rumah Tinggi along the Settlement shoreline as recommended by Beeton *et al*. (2010);
- managing rats within the residential, commercial and light industrial area where they appear most abundant;
- baiting outward from the residential area to remove the majority of individual animals adjacent to the residential area and provide a buffer zone into which dispersing cats would move.

This report focuses on cat control and documents the activities in chronological order conducted over the period July 2011 – August 2012. Also included are the second and third surveys for domestic cats and subsequent veterinary programs in May 2011 and 2012 and commencement of the trapping program in June 2011. Over this period the effort has primarily focussed on the removal of stray/feral cats. Cage trapping has been the primary control technique employed to remove these cats followed by targeted use of leg-hold trapping. Baiting programs along the roadsides/tracks that surrounded the residential and light industrial area were also undertaken, during late September - October 2011 and also June – August 2012.

In 2011, a program to collect data on black rat movement patterns and home range (Low 2012), and also dietary preferences and bait acceptability (Hayes 2011) was instigated to provide information essential to the implementation of an effective and cost efficient rat control strategy. During the course of this program 160 rats were destroyed, the information gained would provide the basis for delivery of rat control programs within the residential, commercial and light industrial zones in 2012-on. Preliminary information on the diseases found in a sub-sample of the cats and rats collected during this program are provided in an earlier report (see Algar *et al*. 2011a). In May/June 2012, a test of these recommendations for optimising rat control within the residential area was

undertaken (Coddou in prep.). These documents are provided as separate reports. An operational baiting program for rats was rolled-out this year commencing along the Settlement shoreline at the Sitting Room to the cliffs below the Tourist Centre. Baiting programs focussed on the Settlement area but were also undertaken in other residential or work places as requested.

1 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). 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 (L. Lumsden pers. comm. 2009). 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); the Red-tailed Tropicbird (*Phaethon rubricauda*) (an EPBC listed marine species); and Forest Skink (*Emoia nativitatis*) and Blue-tailed Skink (*Cryptoblepharus egeriae*) which are not yet listed under the EPBC Act as threatened but are rapidly declining and under threat of extinction.

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 and black rat management and control leading to eradication of one or both target species. This document reports on the commencement of Stage 2, in particular Stage 2(b) (see above, Report Outline).

2 METHODOLOGY

2.1 Site Description

Christmas Island is located in the Indian Ocean (10° 25'S and 105° 40'E) approximately 2,800 km west of Darwin, 2,600 km north-west of Perth, and 360 km south of the Indonesian capital of Jakarta (see Figure 1). The island has an area of approximately 135 km^2 and was formed from an undersea volcano that rose to the surface and has since subsided and risen over geological time. The oceanic island is composed primarily of Tertiary limestone overlying volcanic andesite and basalt (Tidemann *et al*. 1994; Environment Australia 2002). The island rises steeply from the surrounding ocean and consists of a series of fringing limestone terraces, separated by rugged limestone cliffs and scree slopes, rising to an internal central plateau at about 200 m and extending to 360 m above sea level.

The location of work conducted during this current program was primarily confined to the north-east corner of the island within the residential, commercial and light industrial areas. However, trapping was also conducted within and surrounding the Immigration Detention Centre at North West Point. Baiting programs were also conducted outward from this general area.

Figure 1. Location of Christmas Island. Image reproduced from DEWHA website

Christmas Island has a typical tropical, equatorial climate with a wet and a dry season. The wet season is from December to April when the north-west monsoon blows and about 60% of the annual rainfall occurs. For the rest of the year south-east trade winds bring slightly lower temperatures and humidity, and much less rain. Although the seasons are distinct, south-easterly winds may occur in the wet season and some rain may fall in any month of the year. The mean annual rainfall (based on data collected during the past 25 years) is 2,154 mm (Bureau of Meteorology 2009). Most rain falls between November and May with February and March the wettest months, August, September and October are the driest months (op. cit.). The pattern of the average number of rain-days per month follows that of the average monthly rainfall, decreasing from 20 in March to nine in September–October. During the monsoon, heavy downpours lasting several days and periods of humid calm weather are punctuated by gusty north-westerly winds. From May to November, long dry periods with steady south-east trade winds and occasional showers predominate. In years of significant El Niño activity in the Pacific Ocean, rainfall on the island tends to be relatively low. Cyclones and cyclonic swells from the north-west sometimes affect the island during the wet season.

Mean daily temperatures are 23–28 °C in March and April and 22–26 °C in August and September (Bureau of Meteorology 2009). Temperature varies little from month to month. The mean daily maximum is 28 °C in March–April and the mean daily minimum is 22 °C in August–September. Humidity also varies little between months and usually ranges from 80–90 %.

2.2 Domestic Cat Surveys

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 all of 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, across the entire residential area, before the commencement of the veterinary program. The survey process involved doorknocking at each permanent residence and questioning the adult inhabitants as to whether they had any domestic cats. All residences were surveyed and, as added insurance, neighbours were also asked whether domestic cats were present in adjoining houses. All surveyed people were informed of the risk of not declaring the presence of a domestic cat and it not being subsequently registered. The survey recorded the number of owned cats per household, the sex, age, coat colour and whether the animal had been de-sexed previously.

A total of 152 cats (72 females, 79 males) was recorded during the initial survey in October 2010 (Algar *et al*. 2011b). A total of 17% (90 households) of all the permanent residential houses on Christmas Island (n= 526) owned one or more domestic cats. The majority of households (73%) of households owned only one cat, with three households owning more than four cats (n=5, 6, 8) (op. cit.).

The veterinary program is described in detail in Algar *et al*. (2011b). Sixteen cats (six females, 10 males,) of those identified in the survey were unwanted animals and were euthanized. One hundred and thirty-six were micro-chipped and 31 of these cats needed to be de-sexed (nine females, 22 males).

A second survey for domestic cats, across the entire residential area, was conducted in May 2011 and the latest in May 2012. These surveys were undertaken prior to the commencement of further veterinary programs.

2.3 Veterinary Programs

The second veterinary program, conducted in May 2011, was required because four domestic cats were greater than five weeks pregnant and could not be de-sexed safely during the first veterinary program in October 2010. These animals were to be treated with a contraception injection following the birth of the kittens and spayed on a return visit by the veterinarian. A third veterinary program was conducted in May 2012; this was the final program that would be conducted on the island. Any further entire cats trapped or located will be destroyed. The protocols followed during the veterinary program in October 2010 (see Algar *et al*. 2011b) were adopted during these subsequent veterinary programs.

2.4 Trapping Programs

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. The trapping program commenced at the beginning of June 2011 and continued through till mid October 2011. A brief trapping program was conducted in February 2012 during a visit that was primarily undertaken to conduct a rat baiting exercise. A more comprehensive trapping program recommenced in May 2012 and continued through to mid August 2012. Trap sites were selected based on local knowledge of areas frequented by stray/feral cats, as well as areas deemed to be attractive to the target species. In addition, as the program progressed and its success was witnessed by island residents, we were often informed of potential trap locations where cats had been seen. Traps were strategically located within these sites, typically in areas likely to be food sources and thoroughfares.

The trapping program initially used cage traps rather than padded leg-hold traps to minimise the risk of injury to domestic cats. Cats were captured using Sheffield wire cage traps (60x20x20 cm) with treadle plates (Sheffield Wire Products, Welshpool Western Australia). These traps were generally operated over five-day periods. All traps were covered with a hessian sack to provide shelter and protection to the captured animals until they could be collected. The traps were usually baited with cooked chicken

wings (occasionally with fresh mulies (pilchards)) which were treated with the insecticide Coopex 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.

Trapping with cage traps became ineffective towards the end of July 2012. Stray cats that remained were wary of this trap type probably as they had witnessed other cats being caught or they themselves had been trapped and released. Further trapping of stray cats was conducted using padded leg-hold traps (Victor 'Soft Catch' traps No. 3 (Woodstream Corp., Lititz, Pa.; U.S.A.). A mixture of cat faeces and urine or the synthetic olfactory lure Cat-astrophic (Outfoxed, Victoria) was used as the attractant. The traps were deployed on raised platforms to prevent crab access. They were installed either as single units on top of sand-filled 20 l buckets in "one-way" trap sets or in pairs on top of sand-filled truck wheel rims in "walk-through" trap sets. The leg-hold traps were deployed strategically in localized areas where problem cats remained.

Trapped feral cats were euthanized by an intercardial lethal injection (Lethabarb, Virbac Australia). 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. The weight groupings for the cat age classes are provided in Table 1

Table 1. The weight groups for the cat age classes of the trapped population

Category	Male	Female
Kitten	< 1.0 kg	< 1.0 kg
Juvenile	1.0 – 2.4 kg	1.0 – 1.9 kg
Adult	2.5+ kg	2.0+ kg

A number of cats (and also rats) from the major capture sites (see Table 3, Section 3.3) were retained for analysis of stomach contents (Hayes 2011) and also the incidence of disease (Algar *et al*. 2011a). Following euthanasia these animals were stored frozen until

analyses were conducted. Hair and ear notches were also collected for future DNA analysis.

2.5 Baits and Baiting Programs

The feral cat baits (*Eradicat*®) used were manufactured at DEC's Bait Manufacturing Facility at Harvey, Western Australia. Baits were transported to Christmas Island and then kept in frozen storage. The bait is similar to a chipolata sausage in appearance, approximately 25 g wet-weight, dried to 15 g, 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) (see detailed description in Algar and Burrows 2004; Algar *et al*. 2007). Toxic feral cat baits are dosed at 4.5 mg of sodium monofluoroacetate (compound 1080) per bait. Prior to bait application, feral cat baits are thawed and placed in direct sunlight on-site. This process, termed 'sweating', causes the oils and lipid-soluble digest material to exude from the surface of the bait. All feral cat baits are sprayed, during the sweating process, with an ant deterrent compound (Coopex®) at a concentration of 12.5 g 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.

Previous research on Christmas Island has shown that terrestrial non-target species on the island, such as Robber Crabs (*Birgus latro*), Black Rats and feral Chickens (*Gallus gallus domesticus*), would have monopolised the baits if they were laid on the ground, greatly reducing the number of baits available to feral cats (Algar and Brazell 2008). These authors demonstrated a device (gantry) to suspend baits above the ground that effectively stopped bait removal by non-target species yet provided ready access to feral cats (Figure 2).

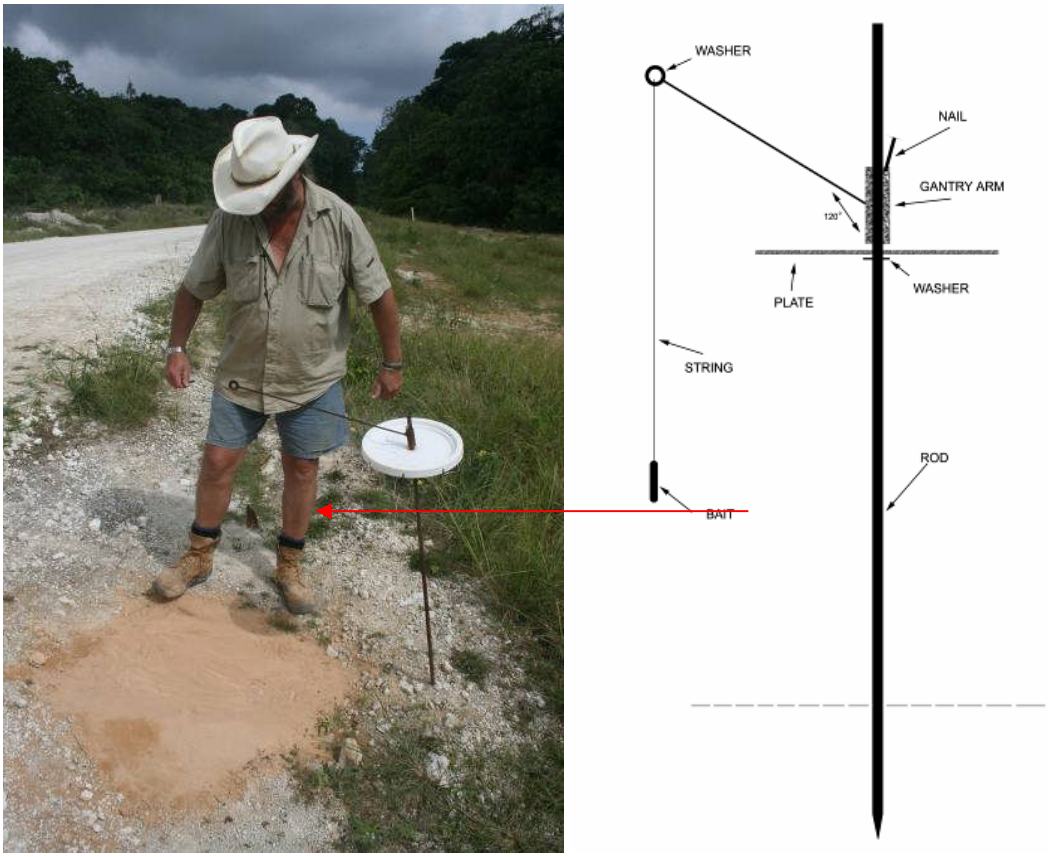

Figure 2. Bait suspension device. Schematic diagram reproduced from Algar and Brazell (2008)

In late September - October 2011 a network of these 'Bait Suspension Devices' (BSDs) was established along approximately 18 km of roadsides/tracks that surrounded the residential and light industrial area. BSDs were located at 100 m intervals on both sides of the road/track, staggered at 50 m intervals across the road/track (Figure 3). A bait, comprising two *Eradicat*® sausages tied at the link, were suspended at a height of about 400 mm from each BSD using 6–8 lb fishing line. Unlike previous programs where a 1 m^2 'sand pad' of crushed phosphate dust was created underneath each BSD to enable the identification of species visiting the site, only BSDs one side of the road/track had sand pads.

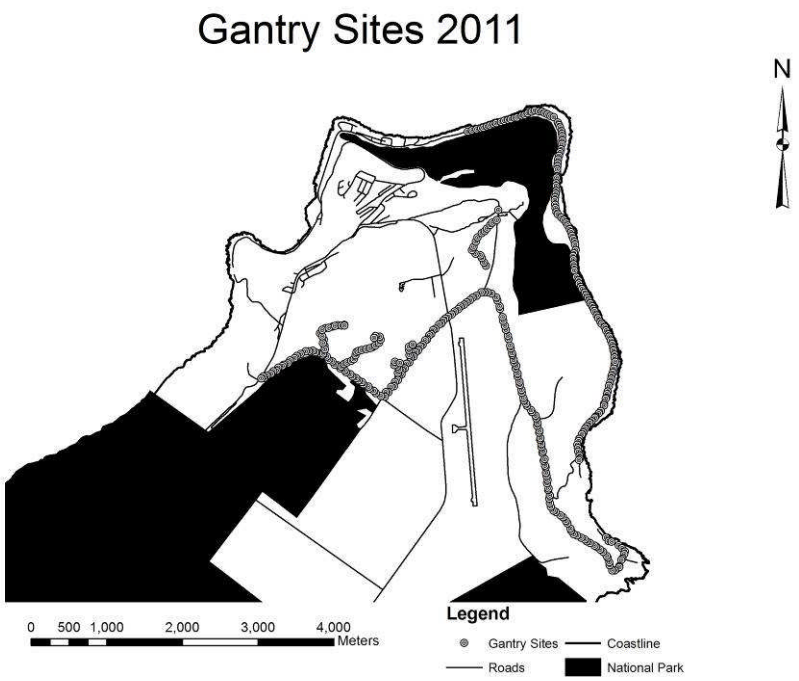

Figure 3. Network of Bait Suspension Devices surrounding the residential and light industrial area in 2011. Figure produced by D. Maple (CINP)

All BSDs were inspected daily over the 20-day baiting period to assess whether baits had been removed. To minimise the amount of toxic baits used, all BSDs were fitted initially with non-toxic baits until a bait had been removed. Baits at this BSD were then replaced with toxic baits.

Bait removal from the BSDs was used to determine the efficacy of the baiting program. It was expected that a non-toxic bait would be taken by a cat, which would then subsequently return and remove a toxic bait. Replacement baits would continue to be provided until all the cats present in the area had eaten a toxic bait and died. Baits were also routinely replaced each week because phosphate dust raised by passing vehicles adhered to the baits and was considered likely to reduce palatability.

A second, more extensive baiting was conducted in 2012 between June and August. This program was in response to a funding application for commencement of Stage 3 in 2012 -2013 being rejected. The baiting program would help to protect the significant investment and gains achieved in controlling stray cats until a new source of funding could be obtained the following financial year. The rationale was that this would remove the majority of individual animals adjacent to the residential area and provide a vacant

buffer zone into which dispersing cats from the rest of the island would move before they reached the residential area.

The baiting program in 2012 adopted recommendations provided in the earlier report (Algar *et al*. 2011a). In the current program only toxic baits were used, baiting along major roads was conducted over ten consecutive days and for five consecutive days along rainforest tracks. In addition, a number of baits stations were strung along walk trials as is proposed in Stage 3 (see Discussion and Recommendations). The locations of BSDs in 2012 are presented in Figure 4.

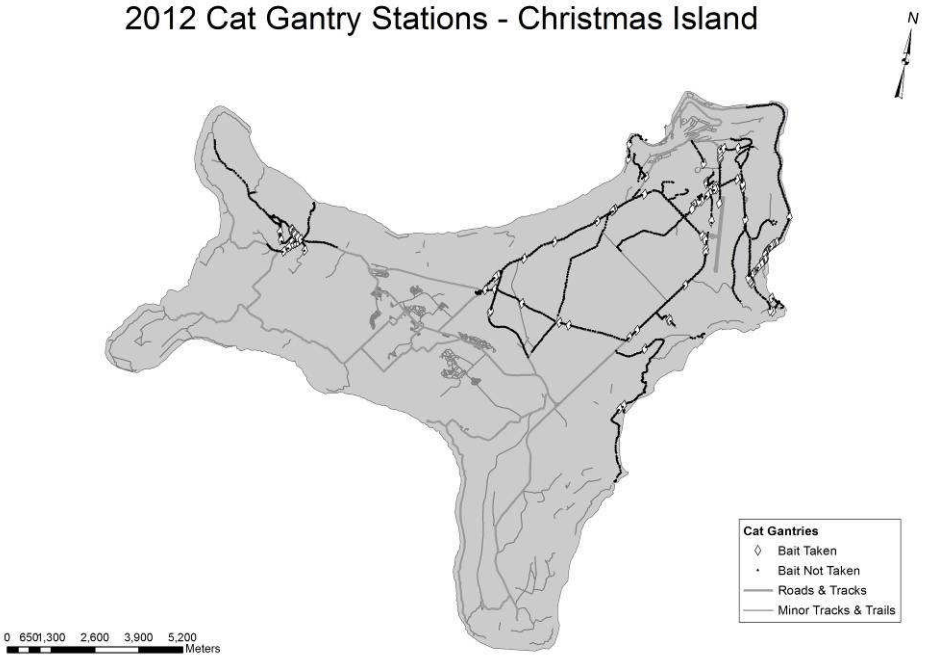

Figure 4. Network of Bait Suspension Devices surrounding the residential and light industrial area in 2012. Figure produced by C. Pink (CINP)

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 two 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.

3 RESULTS

3.1 Domestic Cat Surveys

The survey for domestic cats conducted in May 2011 revealed that of the 136 registered domestic cats 15 (six females, nine males) had died between the first and second survey periods. These animals had either died from natural causes, road fatalities or destroyed as the owners had moved off island.

At the completion of the veterinary program conducted in May 2011 (see below) there were 137 registered domestic cats (68 females, 69 males). The third survey for domestic cats conducted May this year indicated that of these registered animals, 15 (eight females, seven males) were no longer present. Of these cats, seven were road fatalities, five had been exported to the mainland and three had died of natural causes or had been euthanized.

3.2 Veterinary Programs

Unfortunately, two of the four pregnant cats that could not be de-sexed safely during the first veterinary program in October 2010 were not administered with a contraception injection following the birth of the kittens and a second litter of kittens was produced by both cats prior to the second veterinary program. The kittens of one cat treated with contraceptive were destroyed at birth; the other 18 kittens/juveniles still alive were located. Of these animals, three kittens were euthanized; the other 15, along with the four she cats were de-sexed and registered. One female cat registered the previous year `was euthanized following a request by the owner. Two other cats, one of which had been de-sexed some years previously, were considered domestic pets and registered. Thus at the completion of the veterinary program in May 2011 there were 137 registered domestic cats (68 females, 69 males).

The final veterinary program conducted in May 2012 resulted in the registration of a further 12 cats (five females, seven males). Thus at the completion of the veterinary programs there are 134 registered domestic cats (65 females, 69 males) on the island. In addition, the owners of two of these animals have moved to the mainland and the cats have gone missing.

3.3 Trapping Programs

In 2011, 5,121 cage trap-nights were conducted across the residential, commercial and light industrial areas. The trapping program resulted in the removal of the majority of cats from this area, in total 194 stray/feral cats (122 females, 72 males), a biomass of 458.5 kg. Following the removal of these animals, a more strategic trapping program was conducted in 2012, focussing in areas where cats had been observed or reported. The program commenced in February when a limited trapping cage trapping program was conducted during the roll-out of the rat baiting program (149 cage trap-nights). This trapping program resulted in the removal of another 24 stray/feral cats (19 females, 5 males). The trapping program was reconvened in May and continued through to the end of July (451 cage trap-nights). Trapping over this three month period resulted in a further 52 stray/feral cats (32 females, 20 males) being destroyed. Thus in total, the cage trapping program conducted over the period 2011-2012 has resulted in the removal of 270 stray/feral cats (173 females, 97 males), a biomass of 635.3 kg.

Trapping with cage traps was replaced with the use of padded leg-hold traps towards the end of July 2012. Initially they were installed as single units on top of sand-filled 20 l buckets in “one-way” trap sets; these were then replaced with paired traps on top of sand-filled truck wheel rims in “walk-through” trap sets. This trapping program (57 leg-hold trap-nights) resulted in the removal of an additional eight stray/feral cats (four females, four males), a biomass of 24.1 kg.

The general location of all trap points, trap numbers and dates of commissioning and decommissioning are presented in Appendix 1. The age classes of the trapped population, for the various trapping periods, are provided in Table 2 and the general location of captures in Table 3.

Table 2. The age classes of the trapped population

Trapping Period	Category	Male	Female	Total
May-October 2011	Kitten	9	25	**34**
	Juvenile	18	23	**41**
	Adult	45	74	**119**
February 2012	Kitten	0	5	**5**
	Juvenile	3	8	**11**
	Adult	2	6	**8**
May-August 2012	Kitten	2	9	**11**
	Juvenile	6	11	**17**
	Adult	16	16	**32**
Overall Total	**Kitten**	**11**	**39**	**50**
	Juvenile	**27**	**42**	**69**
	Adult	**63**	**96**	**159**

Table 3. The location of captures and number of cats removed

Location	Period			Total Number
	May-Oct. 2011	Feb. 2012	May-Aug. 2012	
Tip, Rec. Centre, IDC (Phosphate Hill)	66	11	15	**92**
Drumsite	48	0	22	**70**
IDC (North West Point)	15	0	0	**15**
Poon Saan + Silvercity	28	12	6	**46**
Kampong, Club Rd. Flying Fish Cove	22	0	10	**32**
Settlement	11	1	7	**19**
Casino	4	0	0	**4**

The male-to-female sex ratio of the total trapped population was 0.57, which differed significantly from unity (χ^2 = 20.78, 1df, P<0.001). This was the case for all age classes (kittens, χ^2 = 15.68, 1df, P<0.001), (juveniles, χ^2 = 3.66, 1df, P<0.05) and (adults, χ^2 = 7.23, 1df, P<0.01).

Of the 74 adult females destroyed in 2011, 44 (59%) were pregnant, 12 (16%) were lactating, 16 (22%) were non-pregnant/non-lactating and 2 (3%) had been de-sexed. Of the 22 adult females destroyed in 2012, 6 (27%) were pregnant, 4 (18%) were lactating, 12 (55%) were non-pregnant/non-lactating.

While conducting the trapping program, 26 registered cats were trapped and returned to their owners, five of these animals were captured twice and one animal three times.

3.4 Baiting Programs

In 2011, bait removal was recorded at 110 of the 365 BSDs (30%) over the 20-day baiting period. Of these, baits were removed at 44 BSDs on more than one night (40%) — sometimes several times over the baiting period — while baits were removed at 66 BSDs on one night only (60%). A total of 164 baits was removed by feral cats over this period, of which 49 (30%) were toxic (Figure 4).

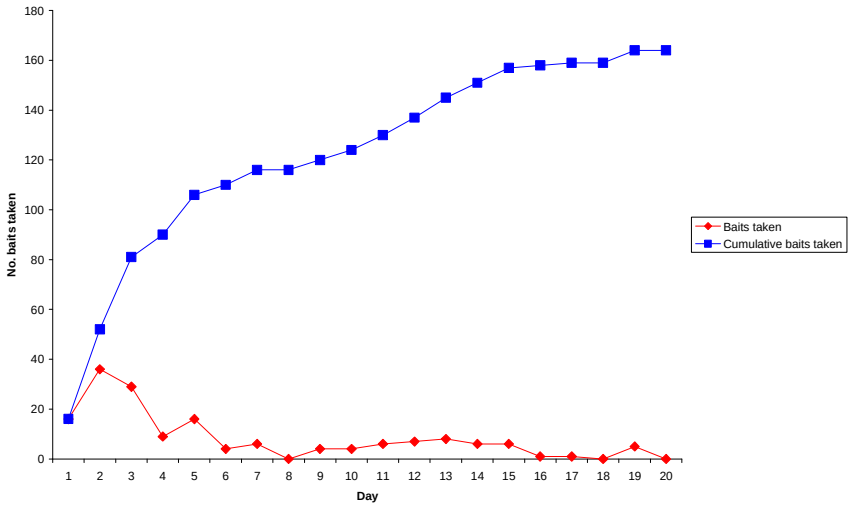

Figure 4. Number of baits removed from BSDs by feral cats in 2011

The total number of toxic baits removed, and by inference the maximum number of individual feral cats poisoned, was 49. The minimum number of cats poisoned was 36 (Figure 5), allowing for individual cats that may have consumed baits from multiple BSDs.

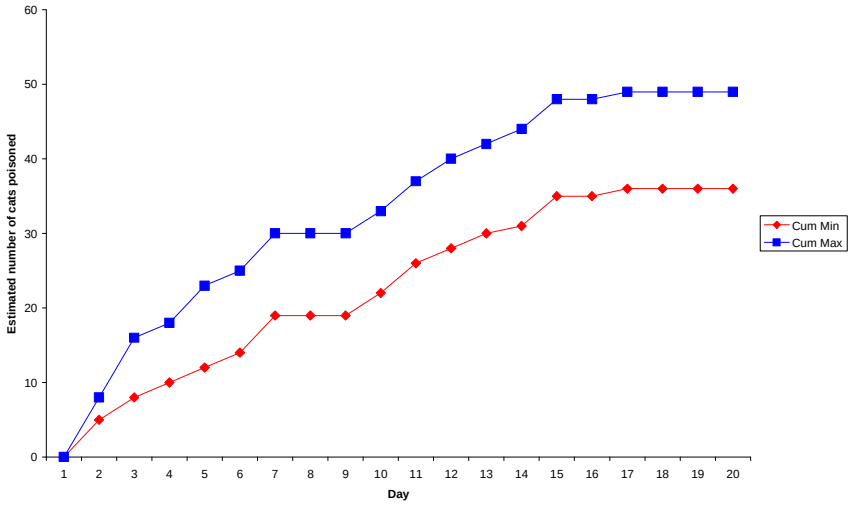

Figure 5. Estimated cumulative minimum and maximum number of feral cats poisoned following consumption of toxic *Eradicat* bait(s) in 2011

In 2012, 1,633 bait stations were established, 1,130 on BSDs over a ten-day period, 408 on BSDs over a five-day period and a further 95 left in place on walk trails. Bait removal was recorded at 110 of the 1,538 BSDs (7%) over the baiting period. Of these, baits were removed at 25 BSDs on more than one night (23%) — sometimes several times over the baiting period — while baits were removed at 84 BSDs on one night only (77%). A total of 142 toxic baits was removed by feral cats over this period (Figure 6).

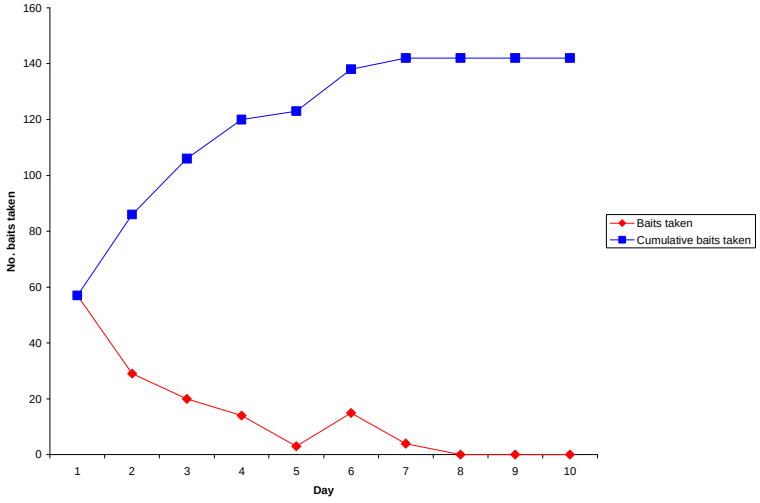

Figure 6. Number of baits removed from BSDs by feral cats in 2012

In 2012, the total number of toxic baits removed, and by inference the maximum number of individual feral cats poisoned, was 142. The minimum number of cats poisoned was

103 (Figure 7), allowing for individual cats that may have consumed baits from multiple BSDs.

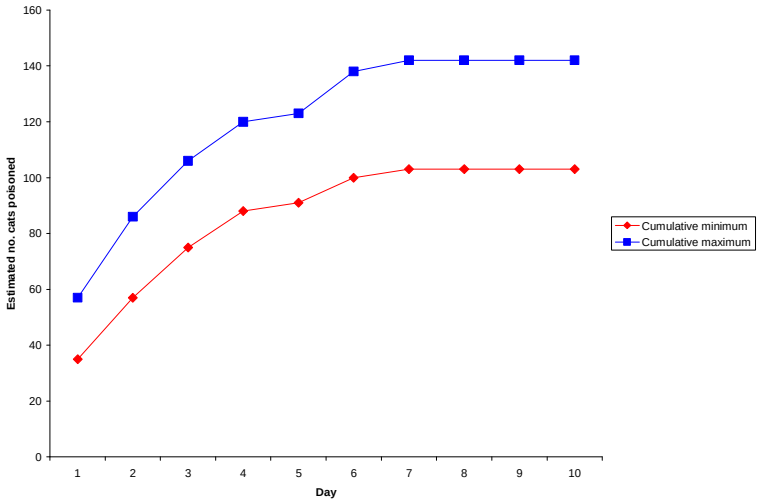

Figure 7. Estimated cumulative minimum and maximum number of feral cats poisoned following consumption of toxic *Eradicat* bait(s) in 2012

In 2011, there were 28 occurrences when consecutive baits were removed from adjoining BSDs on the same day (data for major roads only, not the narrower tracks). On 13 of these occasions bait removal occurred on both sides of the road and on 15 occasions, bait removal was restricted to one side of the road only. In 2012, there were 24 occurrences when consecutive baits were removed from adjoining BSDs on the same day. On 15 of these occasions bait removal occurred on both sides of the road and on nine occasions, bait removal was restricted to one side of the road only.

The number of stray/feral cats removed by each control method, used over the periods May–October 2011, February and May–August 2012, is summarised in Table 4.

Table 4. Number of stray/feral cats removed by each of the control methods

	Control method			
Time period	**Cage traps**	**Leg-hold traps**	**Baiting**	**Total**
May–October 2011	194	-	36-49	230-243
February 2012	24	-	-	24
May–August 2012	52	8	103-142	163-202
Total	270	8	139-191	417-469

4 DISCUSSION AND RECOMMENDATIONS

The final registration of all domestic cats was completed in May 2012 and resulted in 134 owned cats being registered within the residential area of Christmas Island. The surveys for domestic cats conducted over the past three years suggest that the 'model of domestic cat decrease over time', based on an average lifespan of 15 years, is underestimated. The model indicated that domestic cats would no longer be present on Christmas Island by 2024 (Algar *et al*. 2011b) however, the attrition rate is higher than predicted, particularly because of road fatalities, and the island is likely to be free of domestic cats much earlier.

The substantial cat control effort conducted in the residential, commercial and light industrial area since May 2011, primarily through cage-trapping and more recently with targeted leg-hold trapping has removed 278 stray/feral cats from the area. This successful campaign has led to the majority of stray/feral cats being destroyed within this zone. This will now enable the adoption of a more strategic focussed approach in future trapping programs, particularly through the use of leg-hold traps, to remove the remaining stray/feral cats.

An additional benefit of the de-sexing program in conjunction with removal of so many stray/feral cats through trapping appears to be the reduction in the incidence of pregnancy in the adult stray/feral female cat population in 2012. With the number of entire males present in the population declining, the proportion of pregnant stray/feral female cats captured in 2012 was much lower compared with those of 2011, albeit in a smaller population sample.

The two baiting programs have again demonstrated that control/eradication of the feral cat population on Christmas Island would be practicable using *Eradicat*® baits delivered on BSDs. The 2011 baiting program, along 18 km of roadside/track around the periphery of the residential area, removed between 36 and 49 cats over the baiting period. The 2012 more extensive baiting program; using recommendations from the earlier campaign (Algar *et al*. 2011a), resulted in the removal of a further 103-142 stray/feral cats along

approximately 78 km of roadside/track. As a consequence of the combined trapping and baiting programs, between 417 and 469 stray/feral cats have been removed since the commencement of the plan (this figure does not take into account kittens *in utero* that may have survived had the she cat not been destroyed).

To increase the scale of future cat baiting operations across the island, a training and certification course in 'the use of 1080 baiting' was conducted for Parks staff. It will now be possible for Parks staff to routinely bait areas (using biodegradable twine rather than fishing line) as they walk through the National Park undertaking their normal duties. In addition, the 'Island Wide Survey', conducted every two years by Parks staff, provides the opportunity to bait the 900 plots surveyed including the passage *en route*. Management and documentation of this bait deployment will be essential for monitoring its success. An increased baiting effort will greatly improve the effectiveness and cost efficiency of baiting – the primary control technique in the eradication program.

The benefits of cat removal are already being observed particularly in the residential area where the majority of control effort has been focussed. In 2011, for the first time in a number of years, there was a dramatic increase in the nesting success rate of Red-tailed Tropicbird chicks along the Settlement shoreline. On Christmas Island, both domestic cats (identifiable by collars) and stray/feral cats have been photographed predating Red-tailed Tropicbird chicks. The euthanasia of a number of unwanted pet cats from residences along the Settlement shoreline in October 2010 and removal of a number of stray/feral cats from the same area prior to the nesting season is likely responsible, at least in part, for the improvement in the status of this spectacular species (Algar *et al*. 2012). Further removal of stray/feral cats from the Settlement shoreline area in 2011 and 2012, the decline in domestic cats resident in the area and the implementation of a rat baiting program from the Sitting Room to the Tourist Centre have resulted in an even greater Red-tailed Tropicbird nestling success in 2012.

Removal of the majority of the stray/feral cat population has been noticed by much of the community who have commented on the success of the campaign and appreciate the decline in cat numbers. The return to owners of captured domestic cats, when trapped, and discussion of the program with the owners, has also received a positive response.

Both these factors have resulted in the community at large having an optimistic and constructive view of the program.

The enthusiasm with which the general community has embraced the program indicates that there will be further support. The excellent achievements of the program are the result of a substantial effort by a number of dedicated people, made possible, in part, because of funding. Land management agencies on Christmas Island must secure the further funding required to see the project to its successful conclusion and ensure conservation of biodiversity.

5 REFERENCES

Algar D., Angus G.J., Williams M.R. and Mellican A.E. (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. and Brazell R. I. (2008) A bait-suspension device for the control of feral cats. *Wildlife Research* **35**, 471-476.

Algar D. and Burrows N.D. (2004). Feral cat control research: Western Shield review, February 2003. Conservation Science Western Australia 5, 131–163.

Algar D. and Johnston M. (2010). *Proposed Management Plan for Cats and Black Rats of Christmas Island*. Western Australian Department of Environment and Conservation.

Algar D., Hamilton N., Holdsworth M. and Robinson S. (2012). Cat removal implicated in improved nestling success in iconic Red-tailed Tropicbird rookery. *LANDSCOPE* **27(4)**, 43-47..

Algar, D., Hamilton, N. and Onus, M. (2011a). Interim report on Stage 2 of the 'Management plan for cats and Black Rats on Christmas Island'. Unpublished Report to the Shire of Christmas Island and Christmas Island National Parks, Western Australian Department of Environment and Conservation.

Algar D., Hilmer S., Nickels D. and Nickels A. (2011b). Successful domestic cat neutering: first step towards eradicating cats on Christmas Island for wildlife protection. *Ecological Management and Restoration* **12(2)**, 93-101.

Beeton B., Burbidge A., Grigg G., Harrison P., How R., McKenzie N. and Woinarski J. (2010). Final Report of the Christmas Island Expert Working Group to Minister for the Environment Protection, Heritage and the Arts.

Bonnaud E., Zarzosa-Lacoste D., Bourgeois K., Ruffino L., Legrand J. and Vidal E. (2010). Top-predator control on islands boosts endemic prey but not mesopredators. *Animal Conservation* **13(6)**, 556-567.

Bureau of Meteorology (2009). Climate statistics for Australian locations. Website viewed 23 December 2009 (www.bom.gov.au/climate/averages/tables/cw200790.shtml).

Coddou A. (in prep.). Baiting effectiveness for introduced rats (*Rattus sp.)* in Christmas Island. Master of Science (Zoology), Faculty of Natural and Agricultural Sciences, University of Western Australia.

Dickman C.R. (1992). Conservation of mammals in the Australasian region: the importance of islands. In: *Australia and the Global Environmental Crisis*, (eds. J.N. Coles and J.M. Drew) pp. 175-214. Academy Press, Canberra.

Environment Australia (2002). Third Christmas Island National Park Management Plan. Environment Australia, Canberra.

Hayes G. (2011). Dietary study of feral cats (*Felis catus*) and black rats (*Rattus rattus*) to determine predatory impact and identify bait preference for use in a rat eradication program. Bachelor of Science (Wildlife Management), Research Project SCIE4501 – 4504. Faculty of Natural and Agricultural Sciences, University of Western Australia.

Low B.W. (2012). Rats in Paradise – Abundance and Home Range Size on Christmas Island. Bachelor of Science (Conservation Biology Honours), School of Animal Biology, University of Western Australia.

Ratcliffe N., Bell M., Pelembe T., Boyle D., White R.B.R., Godley B., Stevenson J. and Sanders S. (2009). The eradication of feral cats from Ascension Island and its subsequent recolonization by seabirds. *Oryx* **44(1)**, 20-29.

Tidemann C.R., Yorkston H.D. and Russack A.J. (1994). The diet of cats, *Felis catus*, on Christmas Island, Indian Ocean. *Wildlife Research* **21**, 279-286.

6 APPENDICES

6.1 Appendix 1 The general location of trap points, trap numbers and dates of commissioning and decommissioning

Location	Commissioned	Decommissioned	Trap Numbers	Trap Nights
May – October 2011				
Tip	30/05/2011	3/06/2011	50	250
Rec Centre	2/06/2011	3/06/2011	5	10
Tip	6/06/2011	10/06/2011	50	250
Rec Centre + IDC (Phosphate Hill)	6/06/2011	10/06/2011	22	110
Tracks Tavern including Jalan Ketah Meram Hardpan	14/06/2011	18/06/2011	20	100
12 Jalan Ketah Meram	13/06/2011	17/06/2011	5	25
School Kindergarten/CIP	13/06/2011	17/06/2011	5	25
Power Station and ROM Rd	13/06/2011	17/06/2011	5	25
ROM	13/06/2011	17/06/2011	5	25
Crushers	13/06/2011	17/06/2011	5	25
Crushers Tip and School Pavilion	13/06/2011	17/06/2011	5	25
Tracks Tavern including Jalan Ketah Meram Hardpan	20/06/2011	24/06/2011	20	100
12 Jalan Ketah Meram	20/06/2011	24/06/2011	5	25
School northern Boundary	20/06/2011	24/06/2011	10	50
CIP Seatainers/Labs	20/06/2011	24/06/2011	5	25
Wet Bins/Kiats	20/06/2011	24/06/2011	5	25
Poon Saan Rd Temples	20/06/2011	24/06/2011	4	20
San Chye Loh Temple houses and DIAC Block 564	20/06/2011	24/06/2011	5	25
Old Technical School Rd	20/06/2011	24/06/2011	5	25
DIAC Block 566	20/06/2011	24/06/2011	5	25
outer perimeter IDC (North West Point)	27/06/2011	1/07/2011	18	90
Poon Saan Shops, Lodge and warehouses	27/06/2011	1/07/2011	12	60
Old Poon Saan Shops/sea containers	27/06/2011	1/07/2011	10	50
Jalan Perak DIAC Block 671	27/06/2011	1/07/2011	5	25
CIP Silos Track	27/06/2011	1/07/2011	5	25
DIAC Block 568	27/06/2011	1/07/2011	2	10
Tong Chee Rd	4/07/2011	8/07/2011	5	25
Club Rd	4/07/2011	8/07/2011	15	75
Port Authority	4/07/2011	8/07/2011	5	25
Tip	4/07/2011	8/07/2011	14	70
outer perimeter IDC (North West Point)	4/07/2011	8/07/2011	18	90
Rec Centre IRPC	11/07/2011	14/07/2011	20	80
Club Rd	11/07/2011	13/07/2011	4	12
Interior IDC (North West Point)	12/07/2011	14/07/2011	20	60
Tracks tavern	12/07/2011	14/07/2011	2	6
Kampong	18/07/2011	22/07/2011	20	100
Flying Fish Cove	18/07/2011	22/07/2011	15	75
Lower Gaze Rd.	19/07/2011	23/07/2011	22	110

Gaze Rd Barracks to Mango Tree (inland side)	25/07/2011	29/07/2011	35	175
Gaze Rd Barracks to Sitting Room (coast side)	25/07/2011	29/07/2011	22	110
DIAC 567	25/07/2011	29/07/2011	3	15
Behind Mango Tree along coastal strip to Police Station	31/07/2011	5/07/2011	40	200
Casino Waste and old building	31/07/2011	5/07/2011	10	50
Arenga Close	31/07/2011	5/07/2011	10	50
Rec Centre + IDC (Phosphate Hill)	31/07/2011	5/07/2011	20	100
North West Point water tank (Bkt traps)	31/07/2011	5/07/2011	2	6
Trucking depot	31/07/2011	8/08/2011	1	8
DIAC 567 (Bkt trap)	31/07/2011	8/08/2011	1	8
Phosphate Hill (Bkt trap)	31/07/2011	8/08/2011	1	8
DIAC 568 (Bkt trap)	31/07/2011	8/08/2011	1	8
Gas Bottle Area	2/08/2011	5/08/2011	2	6
Casino building's	7/08/2011	12/08/2011	20	100
Ma Chor Nui Nui Temple	7/08/2011	12/08/2011	2	10
Gas Bottle Area	7/08/2011	12/08/2011	3	15
Boat shed ,Tai Jin house and to treatment work centre	7/08/2011	12/08/2011	15	75
Drumsite/Tracks area	7/08/2011	10/08/2011	6	18
Poon Saan Lodge	7/08/2011	12/08/2011	2	10
Kampong	12/08/2011	18/08/2011	2	12
Tip	14/08/2011	19/08/2011	40	200
Boat shed ,Tai Jin house and to treatment work centre	14/08/2011	19/08/2011	17	85
Bus Shed near School	17/08/2011	19/08/2011	2	4
Information Centre	14/08/2011	19/08/2011	5	25
Quarry Road	21/08/2011	26/08/2011	25	125
Mine Incline from Drumsite to Settlement	21/08/2011	26/08/2011	27	135
Settlement Shop	21/08/2011	26/08/2011	2	10
Plant Hill Road	28/08/2011	2/09/2011	14	80
Kung Wai Lane	28/08/2011	2/09/2011	10	50
1/23 Murray Rd	28/08/2011	2/09/2011	4	20
Casino Area	28/08/2011	2/09/2011	30	150
Silvercity House No 10	29/08/2011	2/09/2011	2	10
Territory Park	4/09/2011	9/09/2011	15	75
Technical College and Community Centre Poon Saan	4/09/2011	9/09/2011	5	25
Seaview Drive Behind Houses	4/09/2011	9/09/2011	6	30
Drumsite/Tracks/Water tank	4/09/2011	9/09/2011	10	50
DIAC 567	4/09/2011	9/09/2011	1	5
Shipping Container Area	4/09/2011	9/09/2011	13	65
Airport Area	4/09/2011	9/09/2011	6	30
Phosphate Hill Area	4/09/2011	9/09/2011	16	80
Retreat Lodge	4/09/2011	9/09/2011	1	5
Quarry Powerline Rd	9/09/2011	16/09/2011	20	140
Phosphate Hill Powerline rd	9/09/2011	16/09/2011	20	140
Cross Country	11/09/2011	16/09/2011	10	50
DIAC 670-674	18/09/2011	23/09/2011	10	50
Interior IDC (North West Point)	18/09/2011	23/09/2011	28	140
School	25/09/2011	30/09/2011	3	15
Pizza shop area	25/09/2011	30/09/2011	5	25

Flying Fish Cove	4/10/2011	9/10/2011	20	100
School	4/10/2011	9/10/2011	3	15
Poon Saan Shops	11/10/2011	16/10/2011	5	25
Total Trap Nights				**5121**
February 2012 (Cage traps)				
DIAC 671	11/02/2012	16/02/2012	8	40
IDC (PH)	11/02/2012	16/02/2012	5	25
9 Seaview Drive	12/02/2012	12/02/2012	2	2
IDC (PH) south	13/02/2012	18/02/2012	10	50
7 Pai Chin Loh	18/02/2102	23/02/2012	2	10
1/23 Murray Rd	18/02/2102	23/02/2012	2	10
Settlement Supermarket	24/02/2012	27/02/2012	3	9
IDC (PH)	25/02/2012	25/02/2012	3	3
Total Trap Nights				**149**
May – July 2012 (Cage traps)				
Buddah Temple Settlement	7/05/2012	12/05/2012	5	25
Trax	7/05/2012	12/05/2012	5	25
Tip	7/05/2012	12/05/2012	10	50
IDC (PH)	7/05/2012	12/05/2012	5	25
Drumsite (Parks)	11/05/2012	12/05/2012	1	1
Jalan Guru	15/05/2012	15/05/2012	5	5
Trax	14/05/2012	17/05/2012	5	15
Kung Wai Lane	26/05/2012	31/05/2012	5	25
Graveyard Settlement	28/05/2012	2/06/2012	3	15
Old Hospital Settlement	28/05/2012	2/06/2012	5	25
Hardpan Settlement	28/05/2012	2/06/2012	2	10
Rock Fence Club Hotel	28/05/2012	2/06/2012	5	25
Coast side Barracks	28/05/2012	2/06/2012	5	25
IDC (PH)	1/06/2012	6/06/2012	3	15
12 Jalan Perak	1/06/2012	6/06/2012	2	10
Kampong, Block 401	3/06/2012	10/06/2012	6	42
IDC (PH) south	8/06/2012	11/06/2012	5	15
School	15/06/2012	20/06/2012	3	15
Trax	16/06/2012	21/06/2012	2	10
Settlement/Poon Saan Hill	23/06/2012	25/06/2012	5	10
Flying Fish Cove	26/06/2012	30/06/2012	5	20
Cross Country	10/07/2012	15/07/2012	5	25
School	18/07/2012	22/07/2012	2	8
Kampong, Block 401	25/07/2012	30/07/2012	2	10
Total Trap Nights				**451**
'One-way'/Walk-through' raised platform traps				
Old Hospital Settlement	15/06/2012	20/06/2012	1	5
Rock Fence Club Hotel	15/06/2012	20/06/2012	1	5
Buddah Temple Settlement	15/06/2012	20/06/2012	3	15
Old Poon Saan Shops/sea containers	15/06/2012	20/06/2012	2	10

Coast side Barracks, police station	26/06/2012	30/06/2012	1	5
Kampong, Block 401, park fence-line	27/06/2012	1/08/2012	2	8
Sunset	27/06/2012	1/08/2012	1	4
Arenga Close	6/08/2012	11/08/2012	1	5
Total Trap Nights				**57**