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A bait efficacy trial for the management of feral cats on Christmas Island

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Front cover photo: Feral cat approaching bait suspension device on Christmas Island (Scoutguard 550 camera)

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The procedures used in this study were approved by the Department of Sustainability and Environment's Animal Ethics Committee under protocol 08/15. The Minister for Home Affairs representing the Australian Government approved the use of para-aminopropiophenone in this study under permit IOT0002. A research permit was granted by Parks Australia to work within the Christmas Island National Park, and the Attorney-General's Department gave permission to conduct work on Crown Land. This project required a referral under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) but was found to not constitute a 'controlled action'.

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Summary

The development of an effective bait and toxin for managing feral cat (*Felis catus*) populations within Australia is regarded as a very high priority in the 'Threat Abatement Plan for Predation by Feral Cats' (DEWHA 2008). A collaborative project has addressed this by using an existing fresh meat bait (Eradicat®) that is known to be attractive to feral cats and developed a toxicant formulation based on para-aminopropiophenone (PAPP). This compound was selected on the basis of its apparent humane mode of action and the published differences in susceptibility between cats and non-target species. Further minimisation of the hazard to non-target species is addressed by presenting the PAPP in a very hard pellet that has been found to be reliably consumed by feral cats but rejected by many other species. The overriding objective of the project is to complete the necessary research to achieve registration of the Curiosity® bait as an agricultural chemical.

A field efficacy trial of the Curiosity® bait was undertaken on Christmas Island in the Indian Ocean during August–October 2009. The objective of this study was to assess whether the bait was an effective tool for the management of a feral cat population in a tropical climate. The activity of feral cats was quantified before and after the poison bait program by measuring the rate of bait removal and visits to 'active' sand pads.

Feral cat activity at the monitoring pads was observed to decrease by 87% in the post-bait monitoring period from pre-baiting levels, indicating that the bait provided an effective feral cat population management technique. The procedures used in this study did not permit determination of the actual number of feral cats that died during the trial. However, this number will be between the estimated minimum of 38 and maximum of 78 feral cats that removed baits containing the PAPP toxicant.

Because the management of feral cats on Christmas Island is complicated by the abundant native crab species that would rapidly consume baits placed on the ground, baits were suspended above the ground from a pre-fabricated device. This trial recorded a very low (1.3%) rate of bait removal by non-target species over a total of 7860 bait nights.

The trial indicated that the Curiosity® bait, when used in conjunction with the bait suspension device, can provide a highly target-specific technique for the management of a feral cat population in a tropical climate.

1 Introduction

1.1 Background

The Australian Government, via the Department of Environment, Water, Heritage and the Arts (DEWHA), has supported the development of a humane and target-specific poison bait to assist with the management of feral cat populations. For the purposes of this study, feral cats are described as cats that 'live and reproduce in the wild (e.g. forests, woodlands, grasslands, wetlands) and survive by hunting or scavenging. None of their needs are satisfied intentionally by people' (DEWHA 2008). A collaborative research program between the Victorian Department of Sustainability and Environment (DSE), the Western Australian Department of Environment and Conservation (DEC) and Scientec Research Pty Ltd (Scientec) has focused on the development of this bait product.

Research into the toxicant para-aminopropiophenone (PAPP) has led to the development of a formulation with demonstrated efficacy in triggering the humane death of feral cats in pen studies (Johnston, unpubl. data). The toxicant formulation is presented in pellet form encased in a specifically developed hard polymer that provides moisture protection but also rapid degradation in acidic environments, such as the stomach. The combination of the PAPP formulation and the polymer encapsulation is known as a 'hard-shelled delivery vehicle' (HSDV). The presentation of this compound in a pellet exploits the difference in feeding behaviour between feral cats and native species and assists in achieving selective delivery to the target species (Marks *et al*. 2006). Feral cats reliably consume large, hard items that many native species reject (Hetherington *et al*. 2007; Forster 2009). A single PAPP HSDV is implanted into one end of each Curiosity® bait.

Field trials are required to test the efficacy of the Curiosity® bait in a range of climatic zones to satisfy the requirements of regulatory authorities responsible for registration of agricultural chemicals. The first field trial was conducted in French Island National Park (Victoria) which has a temperate climate (Johnston *et al*. in prep.). A second field trial was undertaken on Dirk Hartog Island, Western Australia, which has a semi-arid climate (Johnston *et al*. 2009). Island sites were chosen for the initial field trials because of the absence of many native and exotic species that might also consume the bait, thus minimising complexity in bait efficacy assessments.

A trial using the same techniques as described in this report was conducted on Christmas Island between August and November 2008. The results of the 2008 study indicated that a pH buffering process applied during bait manufacture had reduced bait attractiveness, to the extent that the trial was terminated prematurely (Johnston *et al*. 2008).

1.2 Study objective

The objective of this study was to assess whether the Curiosity®* bait was an effective tool for the management of a feral cat (*Felis catus*) population on a tropical island. An overriding objective of the Curiosity® bait development project is to achieve registration of the product as an agricultural chemical by the Australian Pesticides and Veterinary Medicines Authority.

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* Two poison bait products intended for the management of feral cat populations in Australia use the same meat lure, which resembles a chipolata sausage and is composed of kangaroo meat mince, chicken fat and flavour enhancers. When doseed with sodium fluoroacetate (1080) this bait product is known as Eradicat®. When dosed with para-aminopropiophenone (PAPP) it is known as Curiosity®. Eradicat and Curiosity are registered trademarks of the Western Australian and Commonwealth Governments respectively.

2 Method

2.1 Study site

Christmas Island is located in the Indian Ocean (10° 25'S and 105° 40'E) approximately 2800 km west of Darwin, 2600 km north-west of Perth, and 360 km south of the Indonesian capital of Jakarta (Figure 1).

Figure 1. Location of Christmas Island. Image reproduced from DEWHA website (2009)

The island has an area of approximately 135 km^2, of which about 85 km^2 (63%) is managed as the Christmas Island National Park. Christmas Island was first identified by Europeans in 1615 but not extensively explored until 1887 when deposits of phosphate were discovered. The island was formed from an undersea volcano that rose to the surface and has since subsided and risen over geological time. Terraces have formed around the island as a result of marine reef development and erosion processes.

Christmas Island has a tropical climate with a distinct wet season between December and April and a mean annual rainfall in excess of 2050 mm. Mean daily temperatures are 23–28 °C in March and April and 22–26°C in August and September (Bureau of Meteorology 2009).

The vegetation of Christmas Island has been classified into 13 broad habitat types (Environment Australia 2002). The baiting trial was undertaken in terrace soil evergreen rainforest interspersed with mining fields that contained limestone scree slopes and pinnacles.

Christmas Island is known for a diverse and highly abundant invertebrate fauna, particularly its diverse and abundant land crabs. The most abundant is the Christmas Island Red Crab (*Gecarcoidea natalis*), which has an annual breeding migration in the early wet season. These crabs play a major ecological role by influencing the structure and species composition of the island's rainforest communities (Green 1997). The Robber Crab (*Birgus latro*) is the largest terrestrial crab and is also abundant across the island (Burggren and McMahon 1988; Green 1997).

Phosphate has been mined on the island since 1897. A network of haul roads is maintained across the island, while tracks navigable by 4WD vehicles exist in the national park.

2.2 Baits and baiting program

DEC prepared 7000 unpoisoned baits which were transported to Christmas Island and then kept in frozen storage. The bait resembles a chipolata sausage and weighs approximately 15 g when dried (Figure 2). It is composed of 70% kangaroo meat mince, 20% chicken fat and 10% digest and flavour enhancers (Patent No. AU781829). Scientec Research prepared 1000 PAPP HSDVs, which were transported to Christmas Island and held in a locked refrigerator until required (Provisional Patent No. 200890357).

Figure 2. PAPP Hard Shell Delivery Vehicles prior to insertion into the Curiosity® baits.

Terrestrial non-target species on the island, such as crabs and feral chickens (*Gallus gallus domesticus*), would have monopolised the baits if they were deployed conventionally (i.e. laid on the ground), greatly reducing the number of baits available to feral cats. Algar and Brazell (2008) demonstrated a device to suspend baits above the ground that effectively reduced bait removal by non-target species yet provided ready access to feral cats (Figure 3).

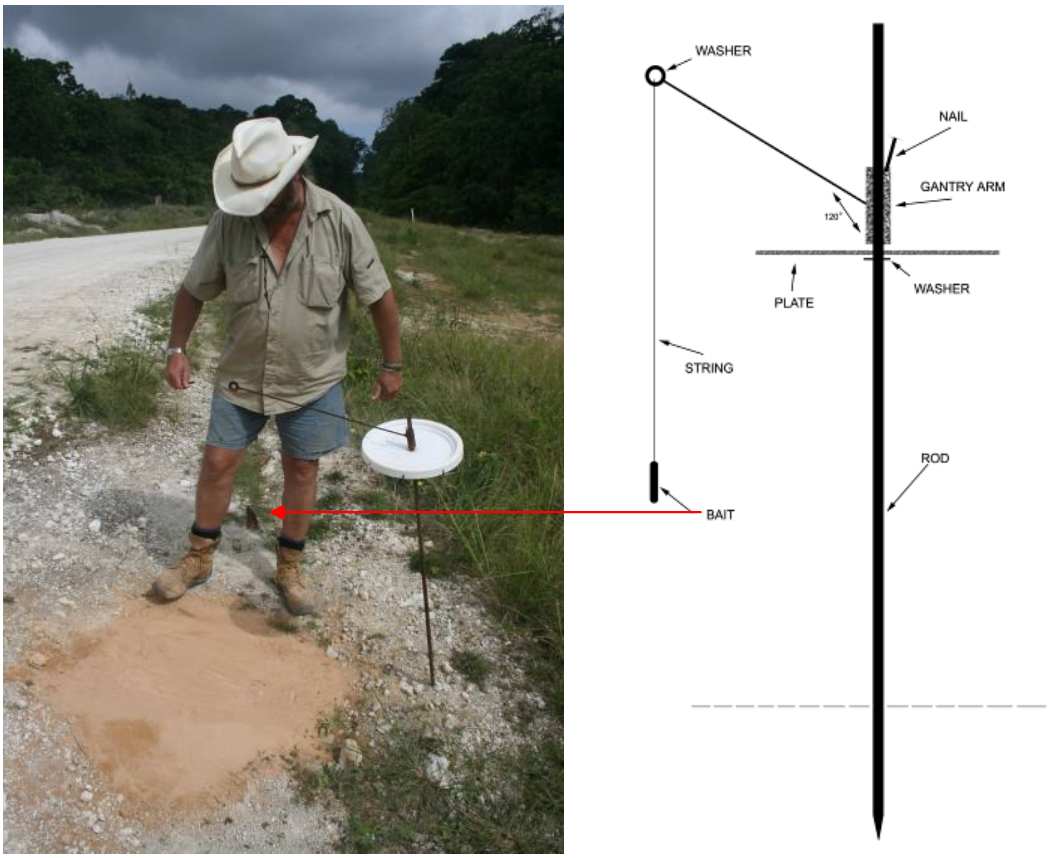

Figure 3. Bait suspension device. Schematic diagram reproduced from Algar and Brazell (2008).

A network of bait suspension devices (BSDs) was established along approximately 50 km of roadsides throughout the study area, at 100 m intervals (Figure 4). Two baits were suspended at a height of about 400 mm from each BSD using 6–8 lb fishing line. A 1 m^2 'sand pad' of crushed phosphate dust was created underneath each BSD to enable the identification of species visiting the site.

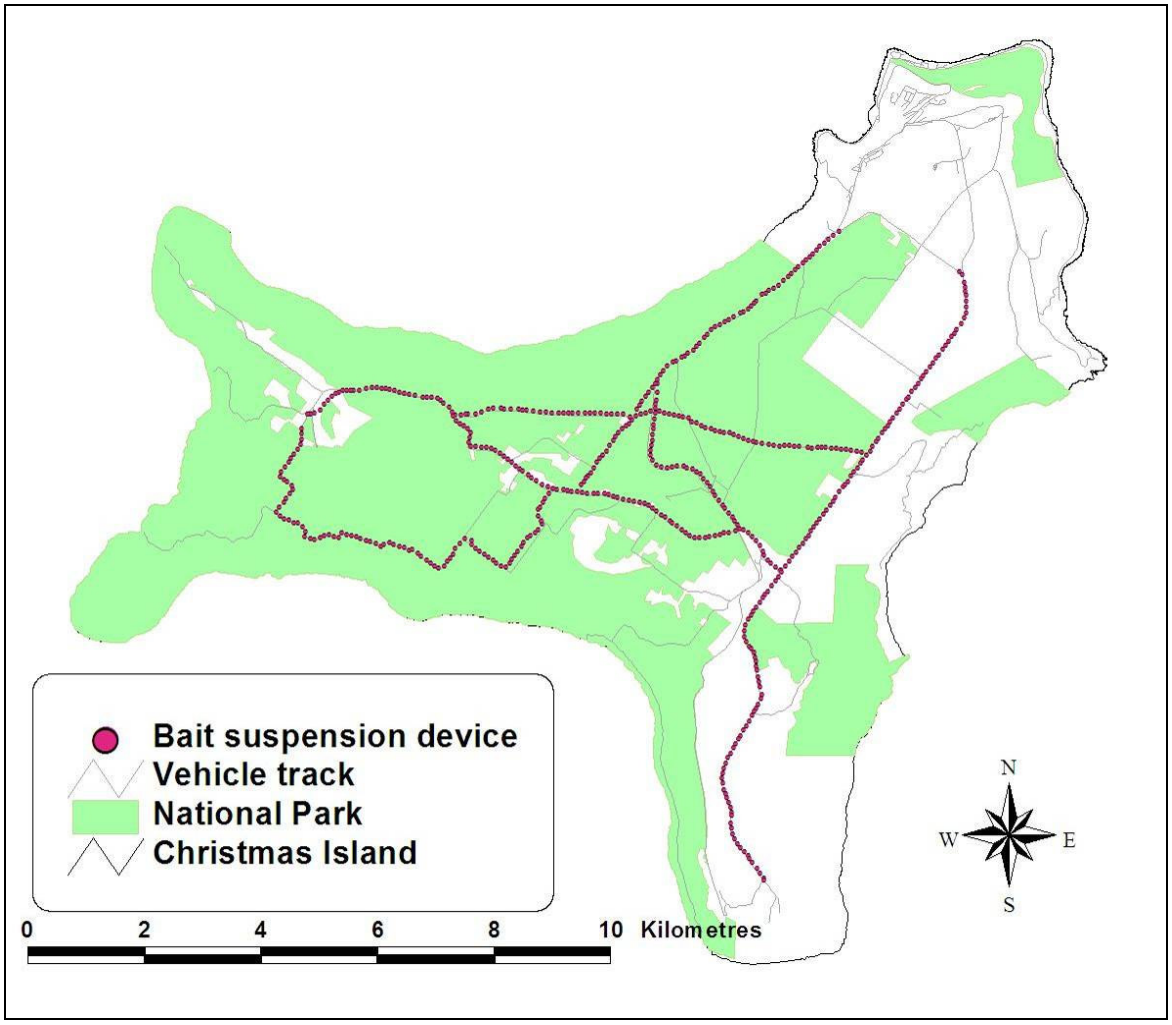

Figure 4. Location of bait suspension devices on Christmas Island.

Animal visits were detected by tracks on the sand pads, which were swept clean each day for a 15 day period (7-21 September, 2009). All BSDs were inspected daily over the baiting period to assess whether baits had been removed. To minimise the amount of toxic baits used in the trial, all BSDs were fitted with non-toxic baits until a bait had been removed and cat prints were observed on the sand pad (Figure 5). Baits at this BSD and its immediate neighbours were then replaced with toxic baits containing a single PAPP HSDV pressed into one end of each bait.

Notices describing the baiting program were published in the local newspaper (*The Islander*), and further information was available from the Parks Australia office. The population of pet and unowned stray cats resident in The Settlement were excluded from accessing baits by restricting the placement of BSDs to within areas of the gazetted national park and mining lease distant from residential areas.

Figure 5. Feral cat activity at a bait suspension device. Note the cat footprints and missing bait.

2.3 Monitoring feral cat activity

Two indices — bait take and cat activity — were used to determine the efficacy of the baiting program. Bait removal from the BSDs was recorded at the sites where cat activity was observed. 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.

As bait station activity could not 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

* It is assumed that a removed bait, including the HSDV, would be eaten.

during this program 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.

Baits were routinely replaced across the whole site every four days because dust from passing vehicles adhered to the baits and was considered likely to reduce palatability. Removal of baits by non-target species was also recorded.

To provide a measure of baiting efficacy independent of a food lure, cat activity was also surveyed at 50 monitoring plots before and immediately after the baiting program. The monitoring plots were also created on the side of the road and consisted of a 1 m^2 'sand pad' of crushed phosphate dust used to enable identification of species visiting the site. An audio lure (Felid Attracting Phonic, manufactured by Westcare Industries) and an olfactory lure (Cat-astrophic, manufactured by Outfoxed, Melbourne) were provided to attract cats to visit the monitoring plots during each survey period (Figure 6). The olfactory lure was presented on cotton wool placed on top of a 400 mm long wooden dowel. Both lures were removed when activity at the plots was not being assessed. These plots were located at 0.5 km intervals along a transect of 5 km, with five transects across the baited zone (Figure 7).

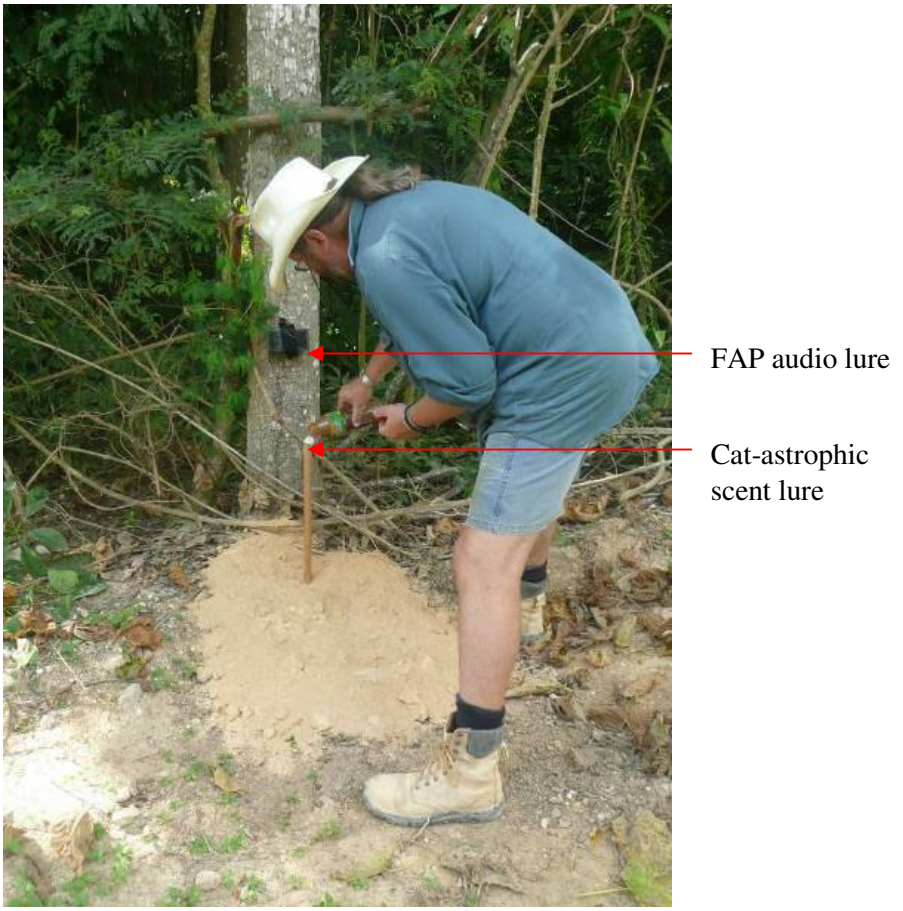

Figure 6. Applying the olfactory lure at a monitoring plot.

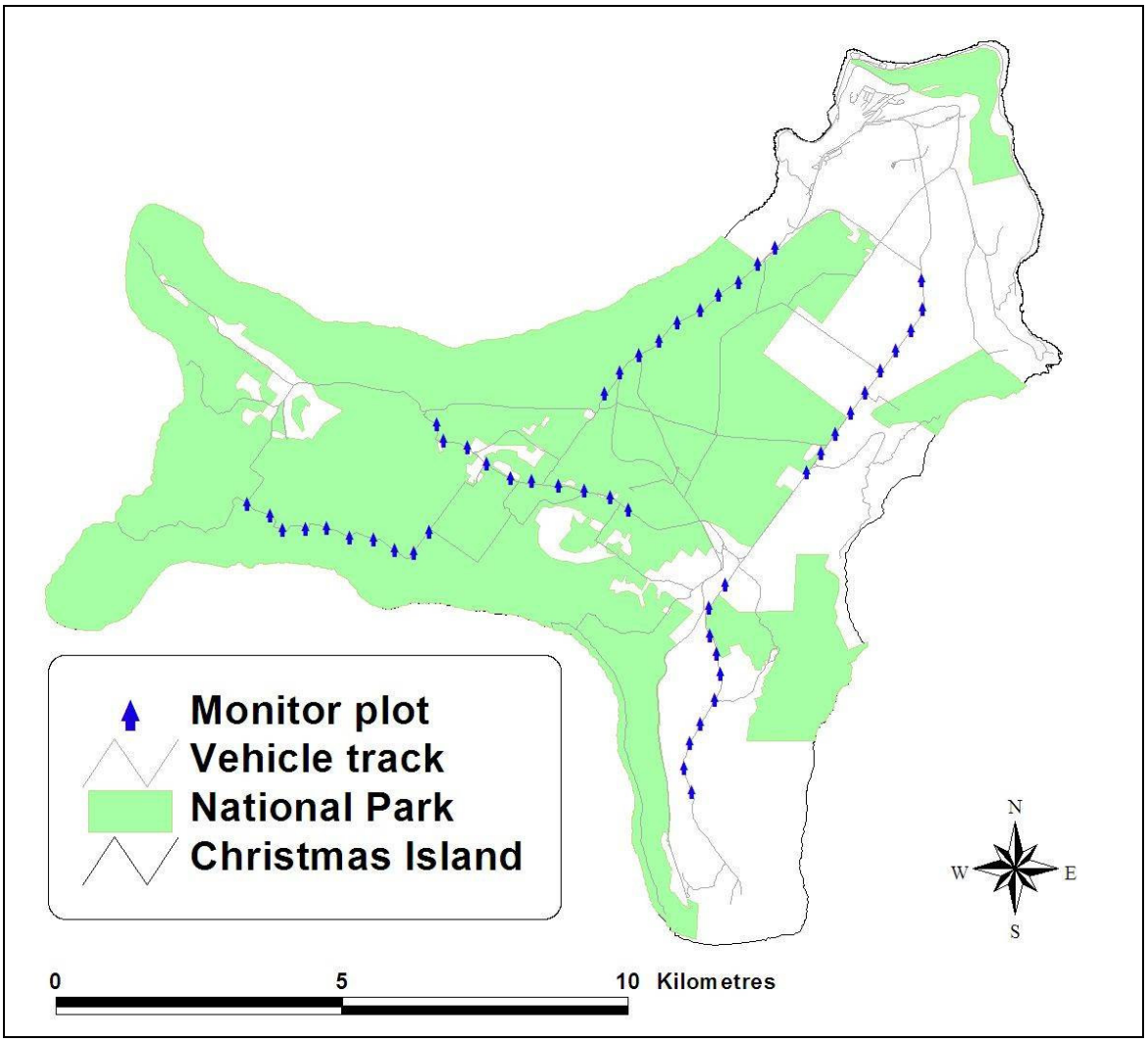

Figure 7. Location of feral cat monitoring plots on Christmas Island.

Cat visits at the monitoring plots were recorded over five consecutive nights prior to (26-30 August) and following (25 -29 September) the baiting period to generate a plot activity index (PAI), which is the mean number of sand pads visited by the target species per night, calculated from the daily means (Engeman *et al*. 1998; Engeman 2005). The VARCOMP procedure within the SAS statistical software package produced the variance component estimates.

3 Results

3.1 Bait removal by feral cats

Cat visits were recorded on 96 of the 524 BSDs (18%) over the 15 days of baiting. Of these, 55 BSDs were visited on more than one night (57%) — sometimes several times over the baiting period — while 41 BSDs were visited on one night only (43%). Two hundred and sixty-five (3.3%) of the 7860 bait nights accumulated in the study involved toxic baits. A total of 183 baits were removed by feral cats over this period, of which 78 (42%) were toxic (Figure 8).

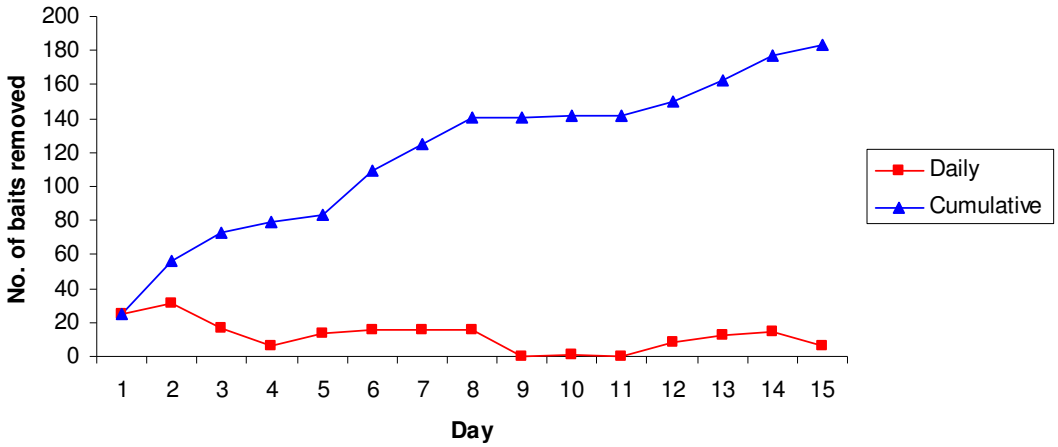

Figure 8. Number of baits removed from bait suspension devices by feral cats.

The total number of toxic baits removed, and by inference the maximum number of individual feral cats poisoned, was 78. The minimum number of cats poisoned was 38 (Figure 9), allowing for individual cats that may have consumed baits from multiple BSDs.

Feral cats removed non-toxic baits from BSDs without making a return visit when toxic baits were available on 43 occasions.

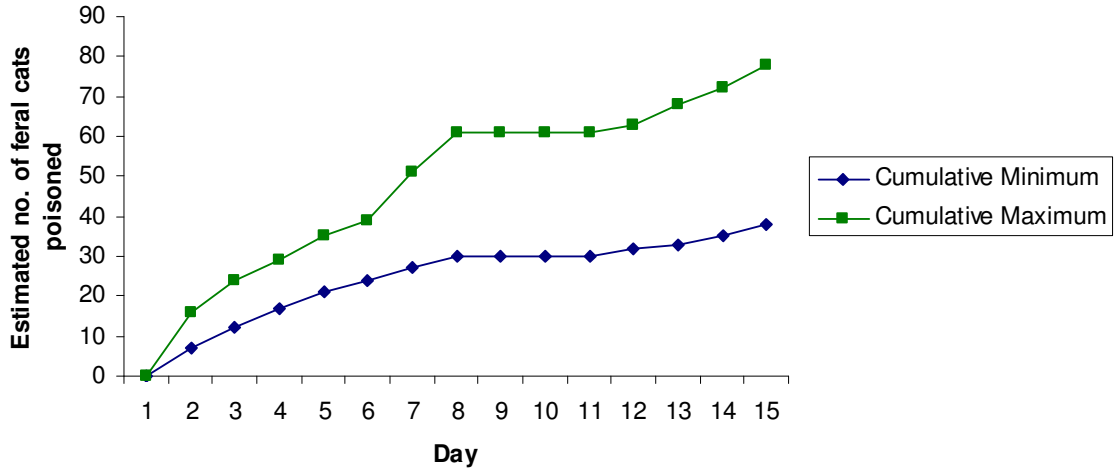

Figure 9. Estimated cumulative minimum and maximum number of feral cats poisoned following consumption of toxic Curiosity® bait(s).

3.2 Cat activity at monitoring plots

A comparison of the Plot Activity Indices for the pre-baiting and post-baiting monitoring periods indicated an 87% decline in feral cat activity following the baiting program (Figure 10).

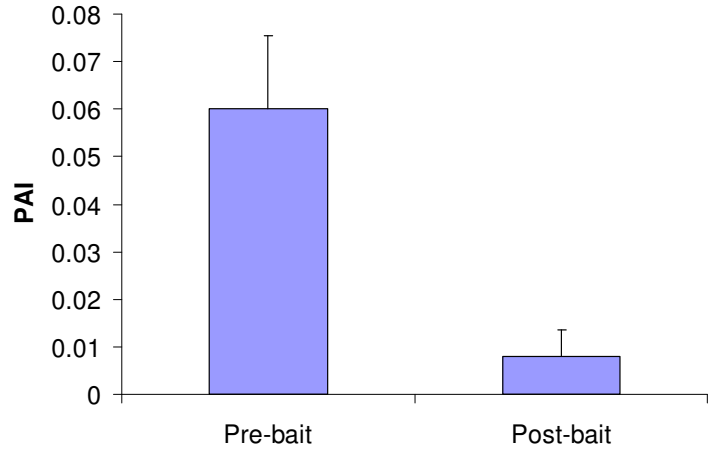

Figure 10. Comparison of Plot Activity Indices with standard errors before and after the baiting program.

3.3 Bait removal by non-target species

A total of 105 baits were removed from BSDs by non-target species — a rate of 1.3% of all bait nights. Robber Crabs and ants were observed on BSDs and are thought to be responsible for bait removal on 60 and 36 occasions respectively. A further nine baits were removed by unknown species (Figure 11).

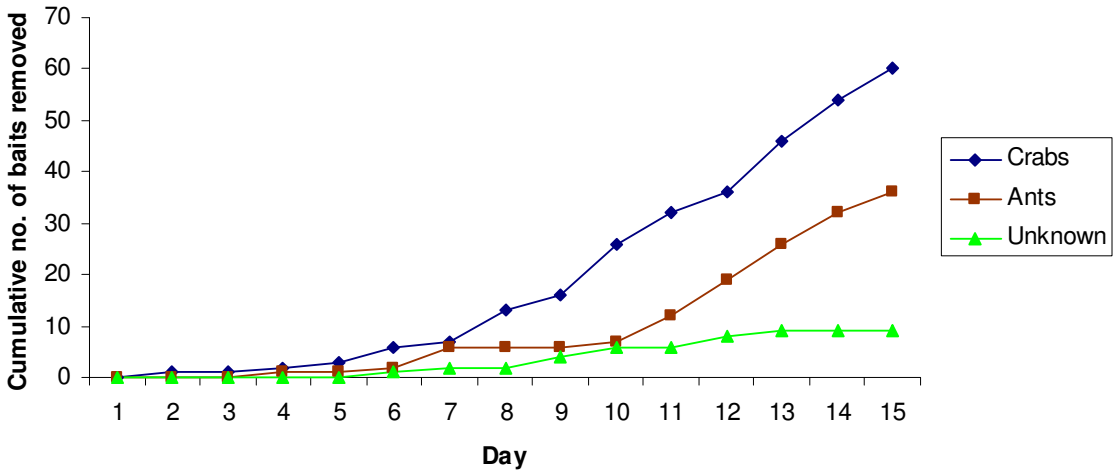

Figure 11. Cumulative bait removal by non-target species.

4 Discussion

This trial has demonstrated that control of the feral cat population on Christmas Island could be practicable using Curiosity® baits delivered on BSDs. This is particularly significant given the abundance and activity of non-target species, such as Robber Crabs, which frustrate the use of conventional ground-based baiting techniques by reducing bait availability to feral cats. Prior to this trial, management of the feral cat population within Christmas Island National Park had been limited and conducted opportunistically by shooting or via the use of cage traps (M. Misso, *pers. comm.*). However, these techniques generally do not achieve significant population reductions at large sites (Fisher *et al*. 2001).

The actual number of feral cats poisoned following consumption of the Curiosity® bait was between 38 and 78. A more accurate figure cannot be determined given that the identification of individual cats was not possible using the sand pads and that it was likely that some cats visited multiple BSDs prior to the onset of symptoms associated with PAPP toxicosis. Results from pen trials indicate the first observable symptoms (lethargy) occur 40 to 80 minutes after bait consumption (Johnston, unpubl. data). The provision of non-toxic baits at each BSD was undertaken to reduce the number of toxic baits used possibly reduced the effectiveness of this trial as a return visit was not recorded following removal of non-toxic baits by feral cats on 43 occasions. It is therefore possible that a greater number of feral cats would be poisoned if non-toxic baits were not used. Furthermore, the availability of alternative or preferred prey may lead to a refusal by some cats to consume this bait despite it being readily available (Algar and Burrows 2004; Johnston *et al*. 2009).

Despite the potential for 'missed' cats, the change in the number of feral cats visiting the monitoring plots indicates that the baiting program led to a rapid reduction in cat activity throughout the site. In the absence of established Australian guidelines for demonstrating product efficacy, the 87% reduction in activity meets the requirements published by the New Zealand Food Safety Authority (NZFSA 2002), an organisation with a similar role to that of the Australian Pesticides and Veterinary Medicines Authority. This trial, together with the trials conducted in other areas using Curiosity® baits (Johnston *et al*. 2009; Johnston *et al*. in prep.), have clearly demonstrated that this bait is an effective product for controlling feral cat populations in a range of different climatic zones.

Poison baiting programs can provide an effective technique for the rapid reduction of feral cat populations (Short *et al*. 1997; Algar and Burrows 2004). However, baits intended for feral cats are usually placed on the ground, which makes them available to a range of non-target wildlife species. The Curiosity® bait minimises the likelihood of non-target species ingesting a lethal dose by delivering the toxicant in a robust encapsulated pellet (Marks *et al*. 2006; Hetherington *et al*. 2007; Forster 2009). However, further measures are required to effectively manage the feral cat population using poison baits on Christmas Island, where the use of surface-laid baits is not appropriate because of the abundance and activity of land crabs. Concern about minimising the access of crabs to baits is two-fold: there is no known data on the susceptibility of crabs to PAPP, and crabs are efficient scavengers that would consume most conventionally laid baits.

In this trial, baits were suspended from a gantry device at a height that gave feral cats easy access but limited access by non-target species such as crabs, rats and birds (Figure 12). A key outcome of this trial was the comparatively small number of baits (1.3%) that were removed by non-target species, indicating that the BSD should be used in future cat-control programs at this site. The consumption of baits by ants might be prevented by the application of a residual insecticide (Algar and Burrows 2004). Robber Crabs climbed around the plate on the BSD to reach the baits on 60 occasions. A larger, less rigid plate may be sufficient to reduce this access.

Figure 12. Non-target fauna interacting with a bait suspension device: (a) robber crabs (*Birgus latro*) and (b) a Christmas Island Goshawk (*Accipiter fasciatus natalis*).

Several improvements were noticed in trial efficacy over a similar trial on Christmas Island conducted in 2008 (Johnston *et al*. 2008). The most obvious difference was an apparent increase in the attractiveness of the baits to feral cats used during the present trial compared to those used in 2008. In the 2008 trial only 50 (0.8%) of the buffered baits were removed by feral cats over a 10-day period (Johnston *et al*. 2008) compared to 142 baits (2%) over the first 10 days in the present trial. This difference was most likely caused by the buffering process used during the production of the 2008 baits, which was intended to prolong the robustness of the HSDV following its insertion into the bait. These buffered baits failed to sweat; that is, the aromatic oils and lipid-soluble digest material did not exude from the surface of the bait as occurs with non-buffered baits.

Although the baits used in this study were apparently more attractive to feral cats than the 2008 baits, they were found to cause premature degradation of the HSDV. Inspection of the HSDVs implanted into baits used in this present trial showed that the polymer had begun to soften within 24 hours of implantation. This indicates that the performance of the HSDV within the bait remains an issue that is yet to be adequately resolved. As a consequence, any baits that contained a HSDV were replaced daily during the trial. Baits also had a tendency to become mouldy after several days, particularly those located in dark and humid conditions within the rainforest. Baits were replaced more often in these areas.

The olfactory lure used at monitoring plots also appeared more attractive to cats in the present study when contrasted to the product used in the 2008 study. The repeated use of the scent and audio lures during both monitoring periods is not considered to have led to a decrease in their 'attractiveness' to feral cats given the 26 day interval when they were not available (Algar, *pers. obs*.).

Future management of the feral cat population on Christmas Island would benefit from the adoption of the techniques used in this study. The use of additional techniques, as well as securing broad community cooperation, would be necessary if land management agencies intend to work towards the eradication of cats and other exotic predatory species that impact on Christmas Island biodiversity.

5 Conclusions

The Australian Government currently seeks to improve the management of ecological processes on Christmas Island to prevent further loss of biodiversity (Garrett 2009). The extent to which feral cats, as a subset of all the cats on the island, contribute to a loss of biodiversity is not currently known. However, given the population decline of potential prey species on the island, such as White-tailed Tropic Bird (*Phaethon lepturus fulvus*) and Christmas Island Blue-tailed Skink (*Cryptoblepharus egeriae*), the eradication of feral cats is highly desirable (Beeten *et al*. 2009).

Specialised techniques are required if significant and broad-scale management of the feral cat population is to be attempted on Christmas Island. This trial has demonstrated that use of the Curiosity® bait when deployed from the bait suspension device provides a highly target-specific and effective technique for reducing feral cat populations at this tropical island site. Increasing the duration and extent of the bait suspension device network would be expected to provide a larger and more widespread level of population reduction.

6 References

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.

Beeten, B., Burbidge, A., Grigg, G., How, R., McKenzie, N. and Woinarski, J. (2009). Revised Interim Report of the Christmas Island Expert Working Group to Minister for the Environment, Heritage and the Arts. Website accessed 24 December 2009 (www.environment.gov.au/parks/publications/christmas/pubs/revised-interim.pdf).

Bureau of Meteorology (2009). Climate statistics for Australian locations. Website viewed 23 December 2009 (www.bom.gov.au/climate/averages/tables/cw_200790.shtml).

Burggren, W. and McMahon, B. (1988). Biology of the Land Crabs. Cambridge University Press (Massachussetts, USA).

DEWHA (2008). Background document for the threat abatement plan for predation by feral cats. Department of the Environment, Water, Heritage and the Arts, Canberra.

Engeman, R.M., Allen, L. and Zerbe, G.O. (1998). Variance estimate for the Allen activity index. *Wildlife Research* **25**, 643–648.

Engeman, R.M. (2005). Indexing principles and a widely applicable paradigm for indexing animal populations. *Wildlife Research* **32**, 203–210.

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

Fisher, P., Algar, D. and Johnston, M. (2001). Current and future feral cat management for conservation outcomes. In: L. Vogelnest and A. Martin (eds), Proceedings of the Veterinary Conservation Biology Wildlife Health and Management in Australasia: July 2001. Taronga Zoo, Sydney.

Forster, G. (2009). Non-target species uptake of feral cat baits containing Rhodamine B. BSc (Hons) thesis. Department of Agricultural Sciences, Latrobe University, Bundoora.

Garrett, P. (2009). Initial response to recommendations of the Christmas Island Expert Working Group Interim Report. Website accessed 24 December 2009 (www.environment.gov.au/minister/garrett/2009/pubs/mr20090701a-attach.pdf).

Green, P.T. (1997). Red Crabs in rain forest on Christmas Island, Indian Ocean: activity patterns, density and biomass. *Journal of Tropical Ecology* **13**, 17–38.

Hetherington, C., Algar, D., Mills, H.R. and Bencini, R. (2007). Increasing the target-specificity of ERADICAT® for feral cat (*Felis catus*) control by encapsulating a toxicant. *Wildlife Research* **34**, 1–5.

Johnston, M., Algar, D. and O'Donoghue, M. (2008). Field efficacy trial of the Curiosity® feral cat bait on Christmas Island. August–November 2008. Unpublished client report for the Department of the Environment, Water, Heritage and the Arts. Arthur Rylah Research Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg.

Johnston, M., Algar, D., Onus, M., Hamilton, N., Hilmer, S., Withnell, B. and Koch, K. (2009). A bait efficacy trial for the management of feral cats on Dirk Hartog Island. Unpublished

client report for the Department of the Environment, Water, Heritage and the Arts. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg.

Johnston, M., Algar, D. and O'Donoghue, M. (in prep.). Field efficacy of the Curiosity® feral cat bait on three Australian islands. In: Proceedings of the Island Invasives: Eradication and Management Conference. University of Auckland, New Zealand.

Marks, C.A., Johnston, M.J., Fisher, P.M., Pontin, K. and Shaw, M.J. (2006). Differential particle size: promoting target-specific baiting of feral cats. *Journal of Wildlife Management* **70**, 1119–1124.

New Zealand Food Safety Authority (2002). ACVM Registration standard and guideline for the efficacy of vertebrate pesticides. New Zealand Food Safety Authority, Wellington, New Zealand.

Short, J., Turner, B., Risbey, D.A. and Carnamah, R. (1997). Control of feral cats for nature conservation. II. Population reduction by poisoning. *Wildlife Research* **24**, 703–714.

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