Field report

Effect of a synthetic lure on site visitation and bait uptake by foxes and wild dogs

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• NSW National Parks and Wildlife Service

• NSW Department of Conservation and Environment

Rob Hunt
Ranger
NSW NPWS
Queanbeyan Area
South West Slopes Region

Effect of a synthetic lure on site visitation and bait uptake by foxes (*Vulpes vulpes*) and wild dogs (*Canis lupis dingo/Canis lupis familiaris*).

Rob Hunt
New South Wales Department of Environment and Conservation, Parks and Wildlife Division, Queanbeyan Area, PO Box 1189 Queanbeyan NSW 2620 Australia.
rob.hunt@environment.nsw.gov.au

Abstract
Bait stations containing unpoisoned commercial fox bait (Fox-Off®) were alternately treated with an aerosol delivered synthetic canid lure to identify any preference for site visitation and bait uptake by wild dogs and foxes. Application of a formulation of Synthetic Fermented Egg (FeralMone™) to the surface of bait stations significantly increased site visitation by wild dogs ($P < 10^{-6}$) and foxes ($P = 0.03$) when compared to the use of buried commercial baits alone. The increase in bait uptake by foxes to SFE treated bait stations was highly significant ($P = 0.002$) when compared to bait uptake at untreated stations, although this effect diminished with time, possibly due to the use of non-lethal baits leading to the discovery of all bait stations and the habituation of animals to sites of reward. Bait uptake by wild dogs, although limited, occurred only at those Fox-Off® bait stations treated with FeralMone™ and was statistically significant ($P = 0.004$). The utilisation of an aerosol based canid lure allowed the volatile ingredients of FeralMone™ to be kept in a stable medium whilst ensuring an easily administered and consistent dose was applied safely by the operator. Pre-baits treated with FeralMone™ were also used as part of this trial in an attempt to increase control point investigations as a result of target animals consuming pre-baits and actively seeking the target scent after 'positive reinforcement' of the scent. Pre-baiting results identified an upward trend in site visitation and bait uptake for both wild dogs and foxes, however further research is required to provide sufficient data for a full statistical analysis. The ability to lure wild dogs and foxes to points of control using an aerosol based synthetic lure (FeralMone™) is effectively demonstrated within the field trial described here.

Introduction

Wild dogs (dingoes (*Canis lupus dingo*), feral dogs (*Canis lupus familiaris*) and their hybrids) and European red foxes (*Vulpes vulpes*) are managed by private and public land managers across Australia in an attempt to address their longstanding impact upon domestic stock and native wildlife (Saunders *et al*. 1995; Fleming *et al.* 2001; Qld Department of Natural Resources and Mines 2003). The most widespread control method utilises lethal baits treated with sodium monofluoroacetate (1080) (Saunders *et al*. 1995; Fleming *et al.* 2001). Land managers involved in long-term lethal canid control programs have expressed concern over continuing medium to high levels of recorded wild dog and fox activity on sand plots (Catling and Reid 2004), despite a significant increase in the presentation of 1080 baits using the buried bait technique (poisoned baits buried 10-15cm below surface level within an earth mound). Issues related to long term bait palatability (von Polanan Petel *et al*. 2001) and/or development of bait aversion or 'bait shyness' associated with the ingestion of sub-lethal doses by the target species (Moss *et al.* 1998; Saunders *et al.* 1999) have been raised during the implementation of cross tenure wild dog and fox control programs in south east NSW (Hunt 2002).

In the United States the use of organic and synthetic scents to lure coyotes to control points has been well documented (Linhart *et al.* 1977; Bullard *et al.* 1983; Blom 1989;

Blom 1994; Phillips *et al.* 1990; Kimball *et al.* 2000) with work undertaken in Australia identifying the potential use of synthetic scent lures for canids under local conditions (Jolly and Jolly 1992; Mitchell and Kelly 1992; Saunders and Harris 2000). Recent studies on coyotes has identified that pre-baiting can increase the attraction of animals to a site where control can be undertaken (Fall and Mason 2002). The objective of this study was to identify any benefit to land managers undertaking canid control programs by using a synthetic scent to attract target species to bait stations. The use of a synthetic scent on unpoisoned pre-baits in an attempt to habituate target animals to further increase control point investigations was also trialled.

Materials and methods

This study was conducted in northern Kosciuszko National Park in New South Wales and Namadgi National Park in the Australian Capital Territory from February to June 2004. These areas were chosen for their remoteness from existing lethal canid (fox and wild dog) control programs and their accessibility via a system of forest trails utilised by management vehicles, bushwalkers, mountain bike riders and in the case of the Kosciuszko transect, both recreational horse riders and wild horses. Anecdotal evidence and canid monitoring studies have consistently identified a resident population of wild dogs and foxes across the selected sites.

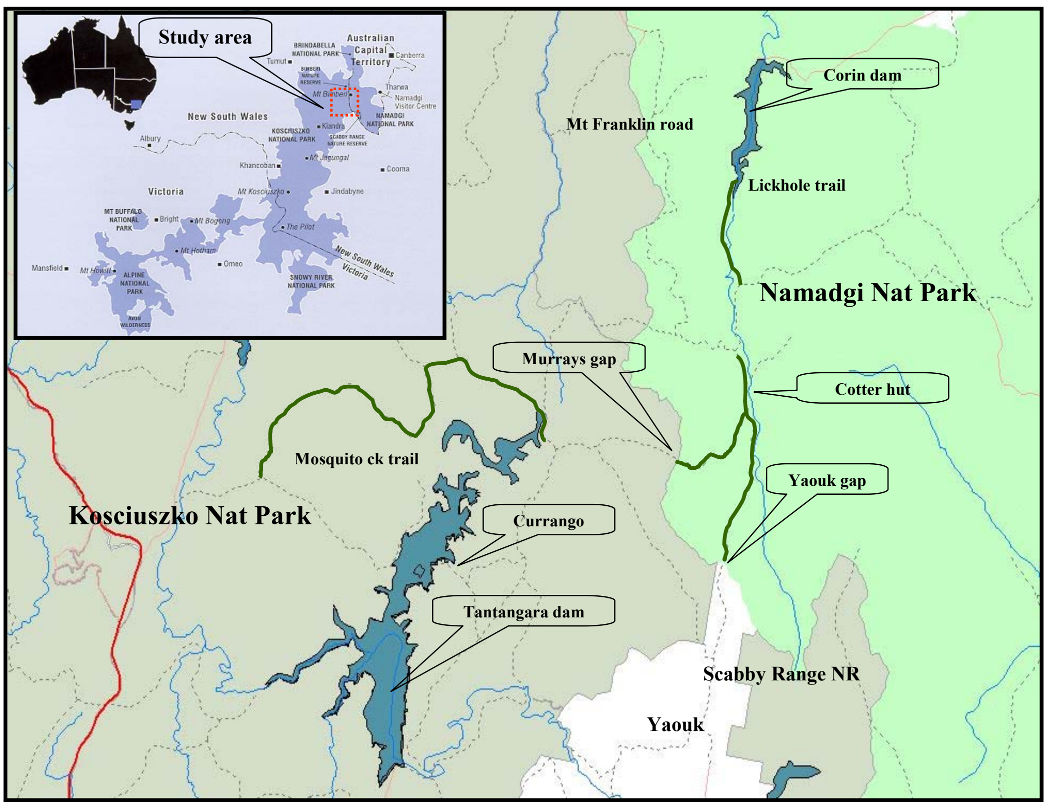


Figure 1. Location of study site within Kosciuszko and Namadgi National Parks (Australian Alps National Parks).

To confirm and monitor the presence of canids sand plots were constructed at the Currango and Namadgi study sites. Sandplots were constructed at 1 km intervals (n = 21 per transect) with one transect established at each of the study sites (Namadgi and Currango). These transects were then checked for 10 consecutive days to give a relative percentage abundance rating for each period of bait presentation (Catling &

Burt 1994, Allen *et al.* 1996, Engeman *et al.* 1998). Wild dog and fox activity on sand plots was recorded as single or multiple canid activity per species in an attempt to identify wild dog and fox interaction along the transects. Disturbance by other species including park user activity on sand plots was also recorded during the sampling periods. Each transect was monitored for two periods with a minimum of 4 weeks break between sampling.

To enable the identification of individual wild dogs on transects remote cameras were utilised. TrailMac (trailsenseengineering.com), motion activated, digital cameras were provided by NSW Department of Environment and Conservation and the Pest Animal Control Cooperative Research Centre (CRC).

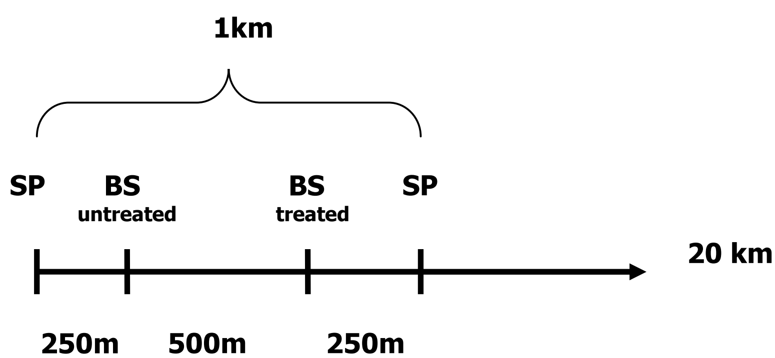
Transects were checked during the following periods:
Namadgi transect No. 1 (no pre-baiting)
Namadgi Trial 1 (24/2/04 - 5/3/04) Namadgi Trial 2 (26/5/04 – 4/6/04)

Currango transect No. 2 (pre-baited)
Currango Trial 1 (4/2/04 - 12/2/04) Currango Trial 2 (15/3/04 - 25/3/04)

An extended time frame for the initial establishment of the Currango transect resulted in 9 days sampling being undertaken during the first Currango sampling period with 11 days sampling being recorded for the second Currango period.

To examine the effect of a scent lure to attract canids, bait stations comprising 50cm x 50cm of sifted earth and bricklayers sand were constructed at 500m intervals (Turkowski *et al.* 1979; Bullard *et al.* 1983; Mitchell and Kelly 1992; Jolly and Jolly 1992) along the Currango and Namadgi 20km transects giving a total of 20 treated and 20 untreated stations per transect. Bait stations were located within 2 metres of the trail edge and each station was baited with an unpoisoned commercial canid bait (Fox-Off®) buried 10 cm deep.

Figure 2. Arrangement of sand pads, treated and untreated bait stations each kilometre along 20 km transect No. 1 (Namadgi).



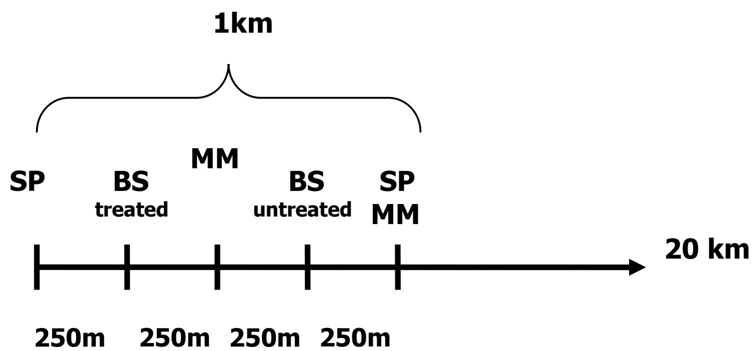
SP = sand plot of raked sand approx 1 metre in width across trail to identify species tracks and calculate relative abundance rating (Catling & Burt 1994)

BS untreated = bait station approx 50cm x 50cm of natural sifted earth with sand added to increase identification of tracks. Fox-Off® free bait (unpoisoned) buried 10cm deep.

BS treated = bait station with application of synthetic lure to bait station.

NSW Parks and Wildlife staff constructing sand plots and bait stations (photo Rob Hunt)

Figure 3. Arrangement of sand pads, treated and untreated bait stations and treated marshmallow pads each kilometre along the 20 km's of transect No. 2 (Currango).



SP = sand plot of raked sand approx 1 metre in width across trail to identify species tracks and calculate relative abundance rating (Catling & Burt 1994)

BS treated = bait station with application of synthetic lure to surface of bait station. Bait consists of Fox-Off® with lure treated marshmallow sandwiched within bait.

MM = marshmallow treated with synthetic lure. MM plot constructed of 50cm x 50cm sand where they do not coincide with SP (sand plots).

BS untreated = bait station approx 50cm x 50cm of natural sifted earth with sand added to increase identification of tracks. Fox-Off® free bait (unpoisoned) buried 10cm deep.

Alternate bait stations were treated with FeralMone™ applied to the surface of the bait station (Pestat Ltd & DEC, PWD development project). FeralMone™ consists primarily of short-chain fatty acids which are also found in canid anal sacs and decaying animal tissue (Mitchell and Kelly 1992, Lapidge 2004). The chemical composition of FeralMone™ (SFE DRC-6503) was provided to NSW National Parks and Yass Rural Lands Protection Board staff as part of an international canid management exchange with US Department of Agriculture (Hunt and McDougall 2003), with the Australian National University, Chemical Department providing laboratory expertise for the initial production of the scent.

Transects were checked daily for 10 days with lure treatments refreshed after 5 days (Linhart *et al.* 1977). Each transect was monitored twice giving a total of 1600 station nights (800 treated/800 untreated).

Spraying bait stations with Feralmone™ (photo Rob Hunt)

Aerosol cans containing Feralmone™ (photo Rob Hunt)

In an attempt to identify any benefit of 'pre-baiting' canids using sweet unpoisoned baits (Fall and Mason 2002), marshmallows sprayed with the SFE mix were positioned at 500m intervals along the 20 km Currango transect giving 40 marshmallow station exposures per night. The marshmallow stations were monitored continuously during the Currango 1 and 2 monitoring periods giving a total of 800 marshmallow nights for the Currango "pre-baited" transect. Pre-bait marshmallow stations were constructed of sifted earth and bricklayers sand to enable the identification of species taking or disturbing 'pre-baits'. Marshmallows were covered with grass/soil sods to restrict uptake by birds. Alternate scented marshmallow placements coincided with 1 km tracking sand plots.

Pre-baits were replaced after 5 days (Linhart *et al.* 1977). Bait stations on the Currango transect within Kosciuszko National Park contained unpoisoned Fox-Off® baits with SFE treated marshmallow sandwiched within the bait to increase palatability and enforce the association with the treated pre-bait marshmallows laid along the transect.

Marshmallow (pre-bait) station (photo Rob Hunt)

FeralMone™ treated marshmallow sandwiched within Fox-Off® bait (photo David Jenkins)

Pre-baiting was not undertaken in the Namadgi transect in an attempt to identify if treated bait stations alone increased bait uptake by canids.
Remote cameras were utilised in an attempt to identify individual wild dogs present within each transect. Additional cameras were provided by Pest Animal Control CRC during the Namadgi 2 monitoring period.

Remote monitoring camera (photo David Jenkins)

Remote monitoring camera (photo Rob Hunt)

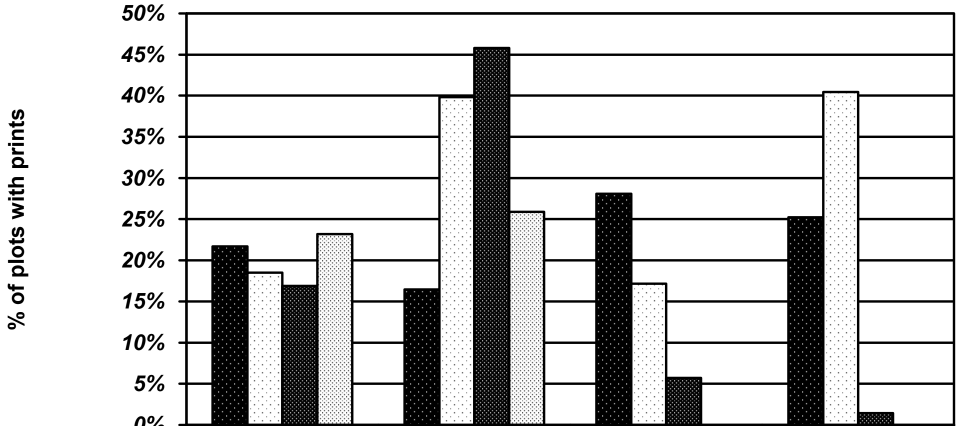
Results

Sand plots

Table 1 presents data on the presence of animals recorded on sand plots. Sand plots identified target, non-target and park user presence within the transects. Sandplot data was calculated to give a relative percentage of abundance per species for each monitoring period by dividing the total number of plots with prints per species by the total number of plot night exposures (no. of sand plots X no. plot nights) (Catling and Burt 1994). Monitoring of plots identified a decrease in wild dog activity on sand plots from Currango 1 (21.69%) to Currango 2 (16.45%). An increase in park users (16.90% to 45.80%) and fox presence (18.51 to 39.82%) was observed during the same period. The combined Namadgi 1 and 2 monitoring periods showed a higher average percentage activity rating for wild dogs (26.66%) on sand plots when compared to the average wild dog activity rating during the pre-baited Currango 1 and 2 transect monitoring period (19.07%). The Namadgi 1 transect period identified similar presence of foxes (17.14%) to Currango 1 (18.51%) however a substantial increase in fox presence was observed for both the Currango 2 (39.82%) and Namadgi 2 (40.47%) monitoring periods. Namadgi 1 identified minimal disturbance in the area from park users (5.7%) with a further decrease in park user disturbance for Namadgi 2 (1.42%).

Wild horses were present within the Currango transect but not within the Namadgi transect. Shod horses (Currango only) were included within the park user category along with mountain bike riders, bushwalkers and unauthorised vehicles.

Table 1. Percentage of plots with prints Currango and Namadgi transects

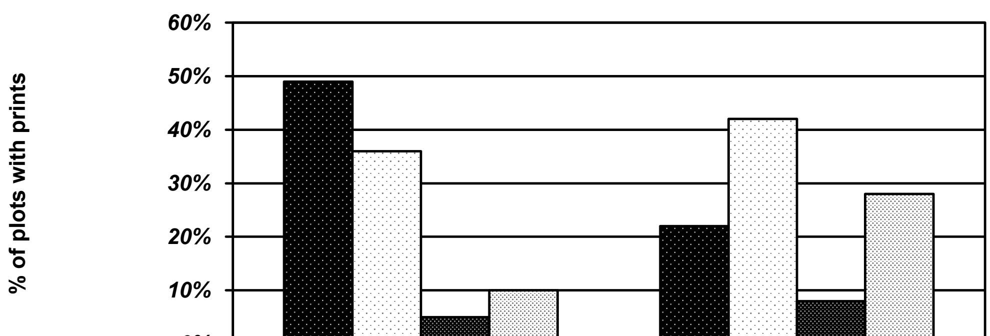


	Currango 1	Currango 2	Namadgi 1	Namadgi 2
wild dogs	21.69%	16.45%	28.09%	25.23%
foxes	18.51%	39.82%	17.14%	40.47%
park users	16.90%	45.80%	5.70%	1.42%
wild horses	23.20%	25.90%	0	0

Shared/sole disturbance on sand plots (park user/wild dog/fox)

A decrease in the percentage of sand plots where only wild dog activity was recorded from Currango 1 (49%) to Currango 2 (22%) coincided with an increase in sole fox disturbance (36% to 42%) for the same period. A slight increase in shared wild dog/park user disturbance from Currango 1 (5%) to Currango 2 (8%) occurred, however shared disturbance on sand plots between foxes and park users increased from Currango 1 (10%) to Currango 2 (28%).

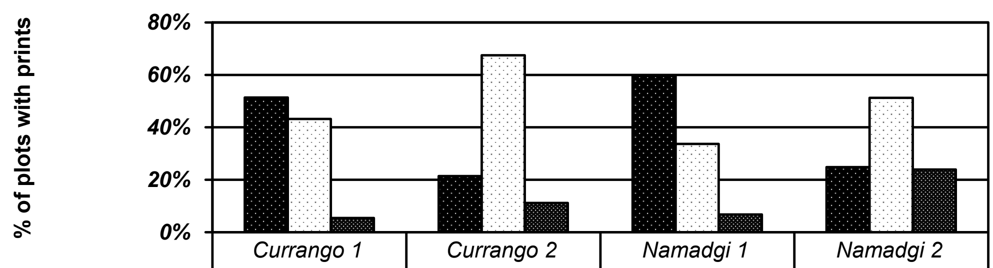
Table 2. Percentage of sand plots with shared/sole disturbance Currango 1 & 2



	Currango 1	Currango 2
wild dog only	49%	22%
fox only	36%	42%
dog & park user	5%	8%
fox & park user	10%	28%

Shared/sole disturbance on sand plots (wild dog/fox)
Shared disturbance on sand plots between wild dogs and foxes occurred on less occasions than sole wild dog or fox disturbance. Although a period of increased park user activity coincided with a marked decrease in wild dog activity between Currango 1 and 2 a constant low level of shared disturbance between wild dogs and foxes was observed during all periods with the exception of Namadgi 2. Namadgi 2 was undertaken during a period of feral pig control activity which resulted in a number of feral pig carcasses being observed adjacent to trails within the transect.

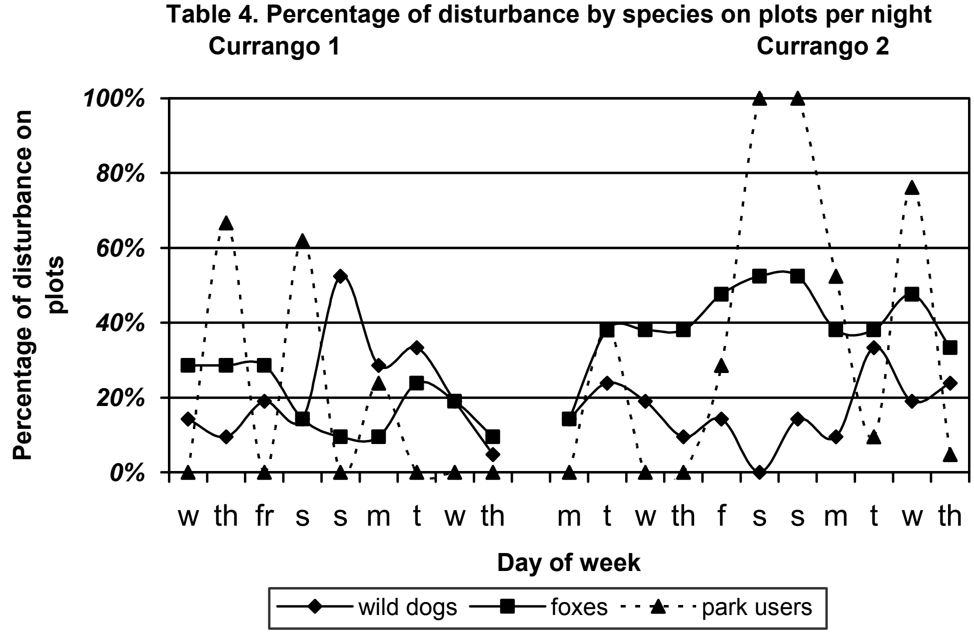
Table 3. Percentage of sole/shared sand plot disturbance wild dog/fox/wild dog & fox



	Currango 1	Currango 2	Namadgi 1	Namadgi 2
wild dog only	51.35%	21.37%	59.55%	24.78%
fox only	43.25%	67.52%	33.70%	51.32%
dog & fox	5.40%	11.11%	6.75%	23.90%

Park user presence
A peak period of park user presence occurred on the weekend of the 20th and 21st of March during Currango 2. This period coincided with the first zero recording of wild dog presence within the transect for Currango 1 and 2. Foxes slightly increased in their activity upon sand plots during this period of increased park user presence.

Table 4. Percentage of disturbance by species on plots per night



Bait stations

Wild dog visits and takes on the Currango transect appeared consistent across the two periods of data collection (Table 13). On the Currango transect more wild dogs visited treated bait stations (n=39) compared to untreated bait stations (n=7). Wild dogs removed six (n=6) baits from treated bait stations. No baits were removed by wild dogs from untreated stations. Four of the six baits removed by wild dogs from treated bait stations were found partly chewed within 2 metres of the treated station with three of these baits having had the treated marshmallow removed from the centre of the bait. Two of the six baits removed by wild dogs from treated bait stations on the Currango transect were not found. Wild dogs urinated on a total of 11 bait stations on the Currango transect with 10 treated and 1 untreated station being urinated upon. One treated station was rolled upon by a wild dog.

Cumulative bait station visits by wild dogs appeared to be consistent across both the Namadgi and Currango transects for both monitoring periods, with treated sites being consistently favoured over untreated sites. As only treated baits were removed by wild dogs, wild dog bait take data was not included within the cumulative graphs. Fox visits during the Currango 1 period are not included within the cumulative graphs as only 4 treated and 5 untreated stations were visited in the first two days of the monitoring period. No baits were taken by foxes for the Currango 1 monitoring period.

Table 5: Cumulative wild dog bait station visits Currango 1 & 2

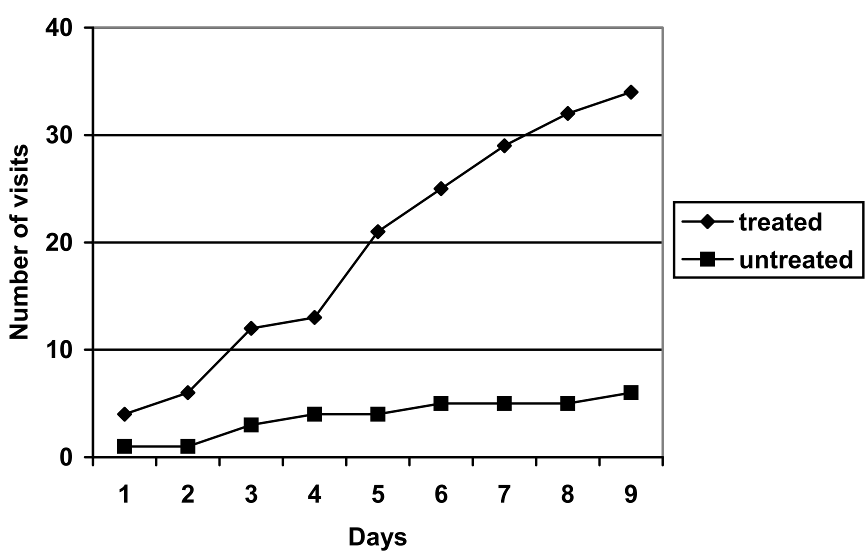
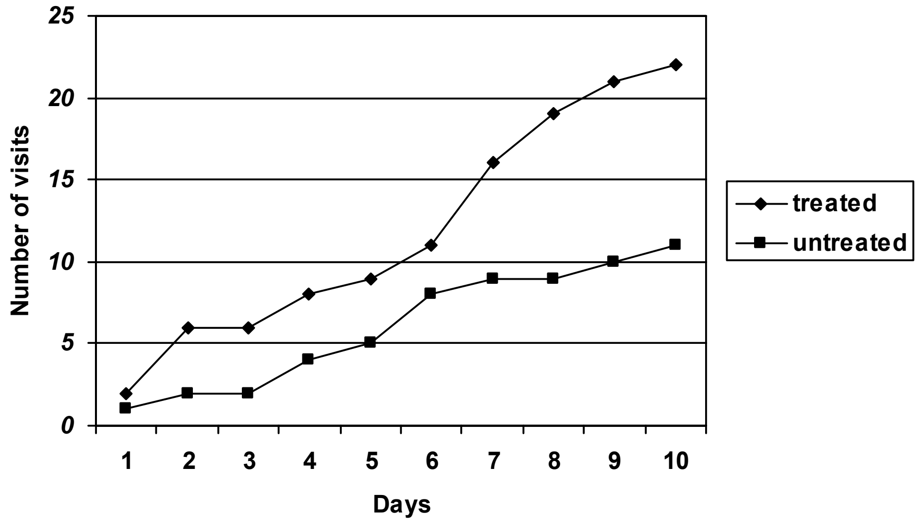


Table 6: Cumulative wild dog bait station visits Namadgi 1 & 2



Cumulative fox visits and takes during the Namadgi 1 monitoring period also identified a clear preference for site attendance and bait uptake at those sites treated with FeralMone™.

Table 7: Cumulative fox bait station visits Namadgi 1

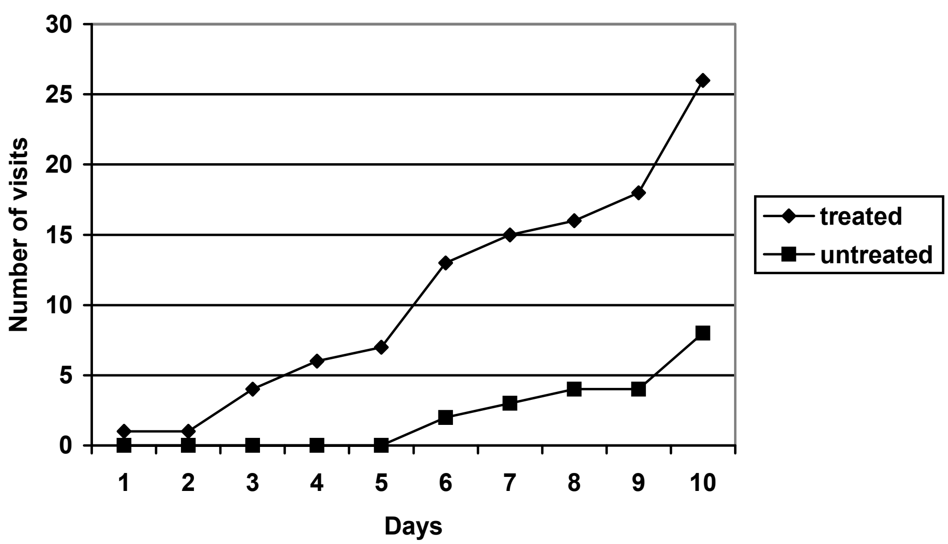
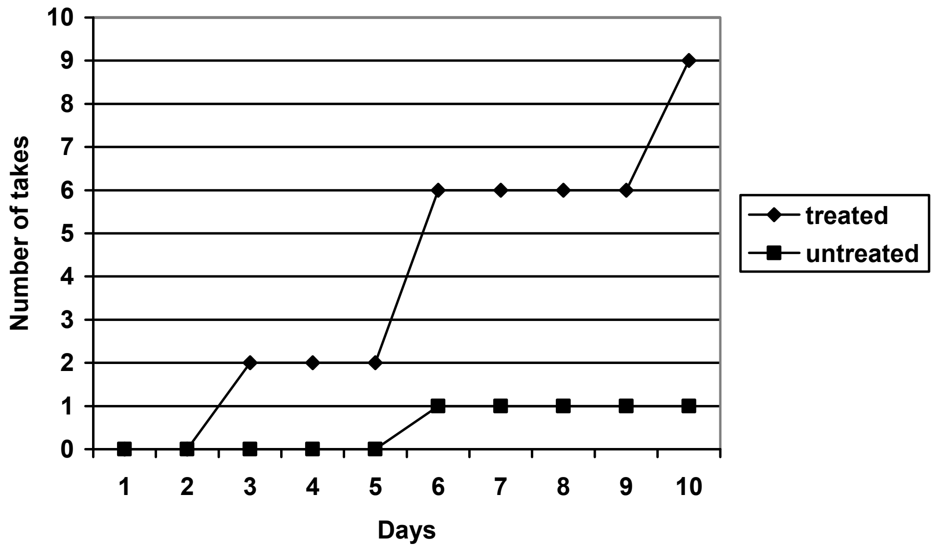


Table 8: Cumulative fox takes at bait stations Namadgi 1



Cumulative bait station visitation and bait uptake for foxes during the second monitoring periods (Currango 2 & Namadgi 2) identified a major increase in site visitation and bait uptake for all bait sites consistent with sand plot monitoring data which identified a major increase in sand plot activity for the second monitoring period on both transects.

Table 9: Cumulative fox bait station visits Currango 2.

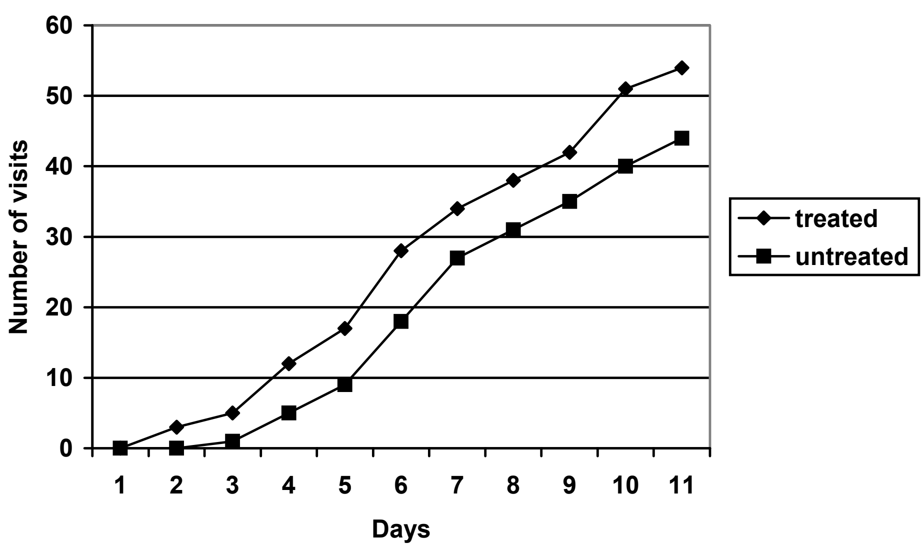


Table 10: Cumulative fox takes at bait stations Currango 2

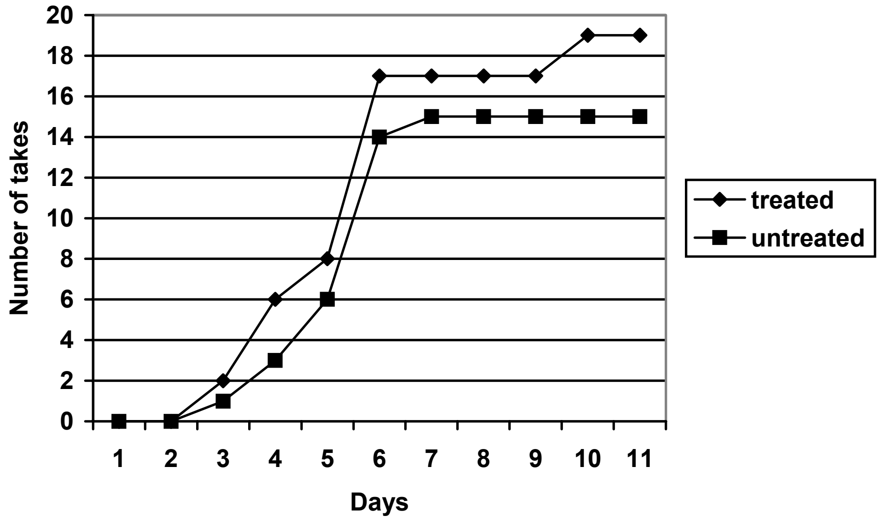


Table 11: Cumulative fox bait station visits Namadgi 2

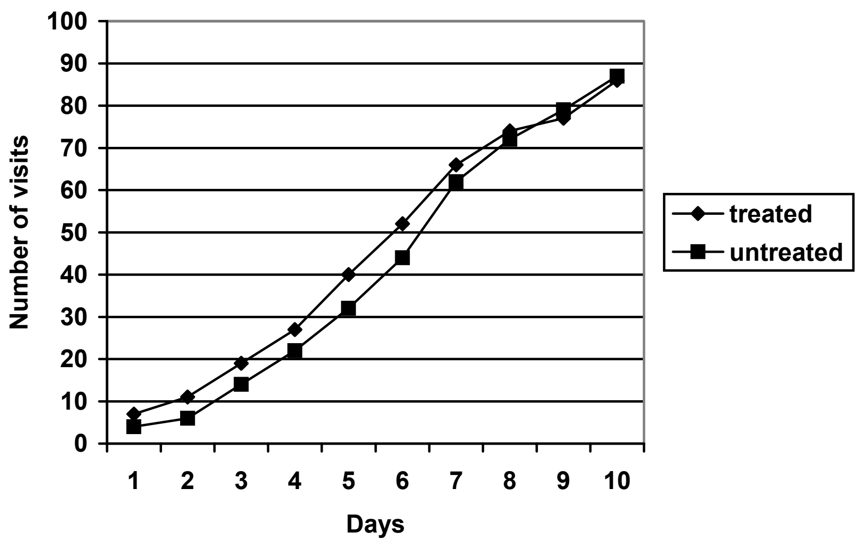
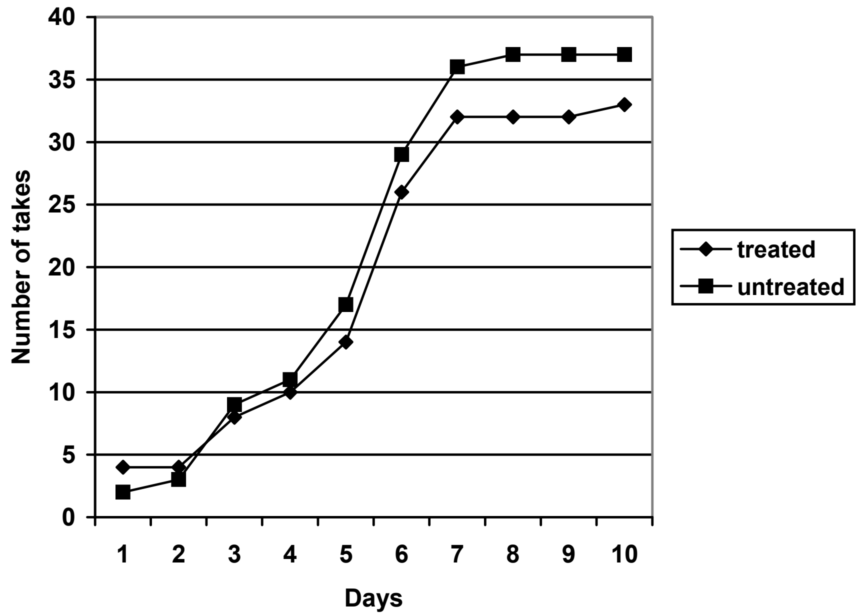


Table 12: Cumulative fox takes at bait stations Namadgi 2



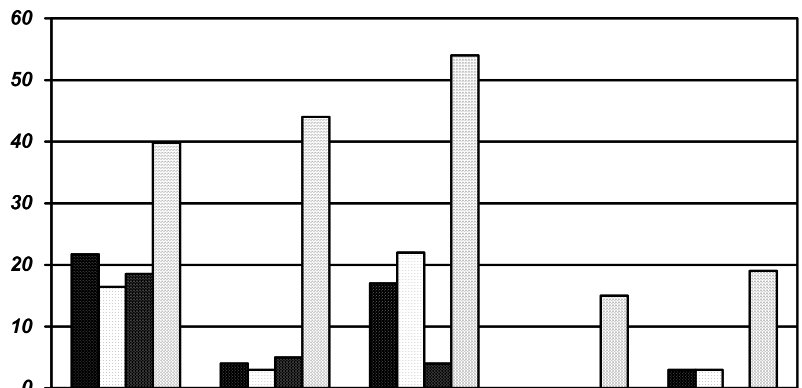
Bait stations on the Currango transect showed variation in fox visitation and takes from Currango 1 to Currango 2. Fox visits during Currango 1 show little difference in preference from treated (n=4) to untreated (n=5) bait stations. Currango 2 identified a minor increase in treated (n=54) to untreated (n=44) bait station visitation for foxes with bait takes also showing a minor difference from treated (n=19) to untreated (n=15) bait stations. An increase in bait station visits by foxes from Currango 1 to Currango 2 was observed by a factor of 13.5 for treated stations and by a factor of 8.8 for untreated stations. An increase in fox sandplot activity by a factor of 2.1 was identified on sand plots from Currango 1 (18.5%) to Currango 2 (39.8%).

The Namadgi 1 period identified differences in wild dog attendance at treated (n=18) and untreated (n=7) bait stations. One bait was taken by a wild dog from a treated station during Namadgi 1. Fox observations identified a difference in takes (n=9) and visits (n=26) from treated stations as compared to untreated takes (n=1) and visits (n=8) for the Namadgi 1 period (Table 14). The Namadgi 2 period identified an increase in the number of fox visits and takes to all stations when compared to Namadgi 1. Namadgi 2 fox visits to treated (n=86) and untreated (n=87) bait stations showed increases from Namadgi 1 by a factor of 3.3 (treated) and 10.8 (untreated). An increase in fox abundance by a factor of 2.3 was observed on sand plots from Namadgi 1 (17.14%) to Namadgi 2 (40.47%). The level of fox abundance increase from Currango 1 to Currango 2 (factor 2.1) and Namadgi 1 to Namadgi 2 (factor 2.3) were similar. Wild dog bait station activity for Namadgi 2 resulted in 1 treated station bait take with no difference between treated (n=4) and untreated (n=4) station visits.

Monitoring of takes and visits to untreated Fox-Off® and treated Fox-Off® bait stations by wild dogs and foxes identified trends in site visits and bait uptake for each bait station treatment. The visit and take data was analysed using a generalised linear mixed model (McCulloch and Searle 2001). A more detailed description of the data analysis is attached as Appendix 1. The application of a formulation of SFE to Fox-

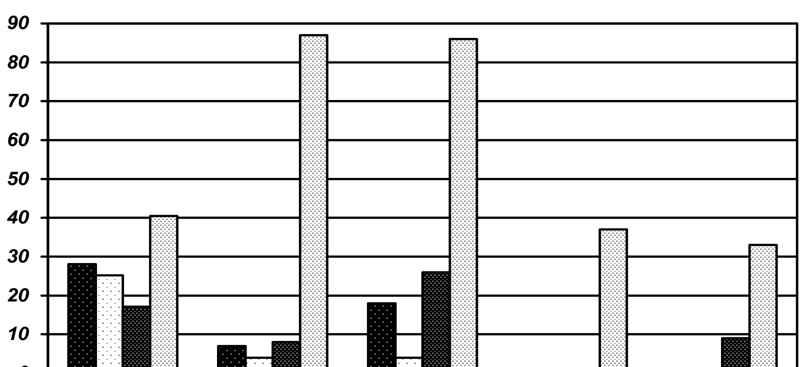
Off® bait stations significantly increased fox visitation ($P = 0.03$) and was highly significant in increasing bait uptake ($P = 0.002$) although the size of this effect significantly decreased with time, possibly due to the use of non lethal baits leading to the eventual discovery of all bait stations and the habituation of animals to sites of reward. Wild dogs showed significantly increased site visits to SFE-treated Fox-Off® stations as compared to bait stations containing Fox-Off® alone ($P < 10^{-6}$). All 8 bait takes by wild dogs occurred at SFE-treated bait stations. Although the data are too sparse to allow for rigorous statistical analysis, from binominal theory the probability of this occurring by chance if there were no significant differences between the stations is significant ($P = 0.004$). No baits were taken from unscented Fox-Off® stations by wild dogs.

Table 13. Wild dog and fox activity: Currango transect



	% presence on plots	*Fox-Off® visit*	*Fox-Off®/SFE visit*	*Fox-Off® take*	*Fox-Off®/SFE take*
Currango 1 wild dog	*21.69*	*4*	*17*	*0*	*3*
Currango 2 wild dog	*16.45*	*3*	*22*	*0*	*3*
Currango 1 fox	*18.51*	*5*	*4*	*0*	*0*
Currango 2 fox	*39.82*	*44*	*54*	*15*	*19*

Table 14. Wild dog and fox activity: Namadgi transect



	% presence on plots	*Fox-Off® visit*	*Fox-Off®/SFE visit*	*Fox-Off® take*	*Fox-Off®/SFE take*
Namadgi 1 wild dog	*28.09*	*7*	*18*	*0*	*1*
Namadgi 2 wild dog	*25.23*	*4*	*4*	*0*	*1*
Namadgi 1 fox	*17.14*	*8*	*26*	*1*	*9*
Namadgi 2 fox	*40.47*	*87*	*86*	*37*	*33*

Unfortunately the effect of pre-baiting is confounded with the location variable, so rigorous statistical analysis of pre-baiting data was not possible. The data does, however, indicate an upward trend in site visitation and bait uptake for both wild dogs and foxes when comparing pre-baited to non pre-baited sites. This is shown in Figure 4 which plots the standardised bait take rate with the sandplot activity at the location. While this plot shows some indication of a pre-baiting effect, confirmation of this outcome will require further research.

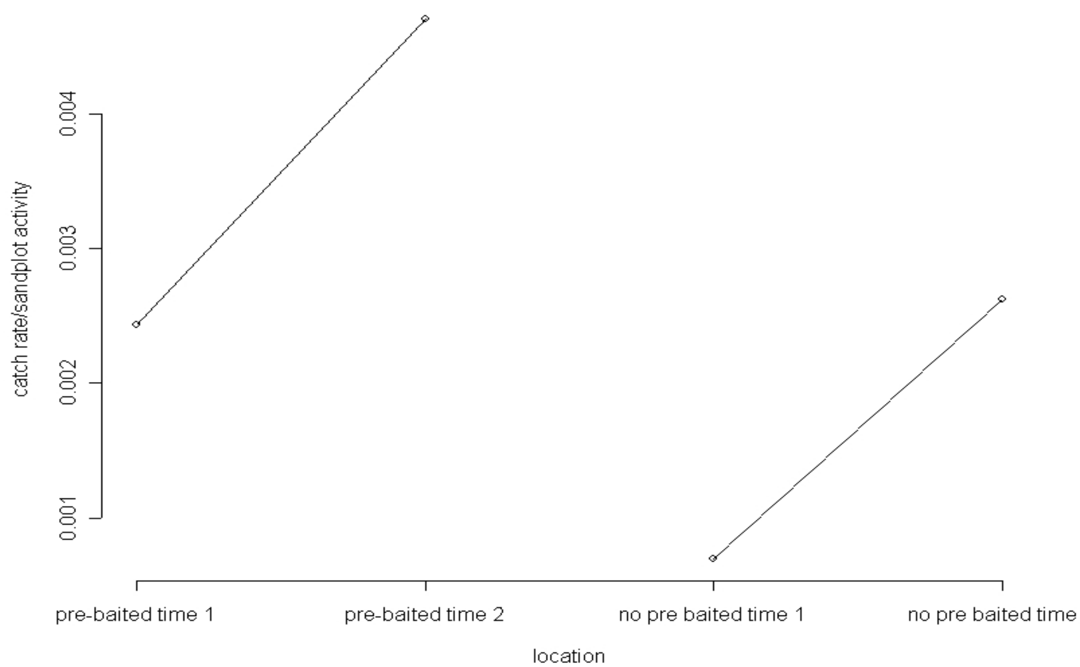
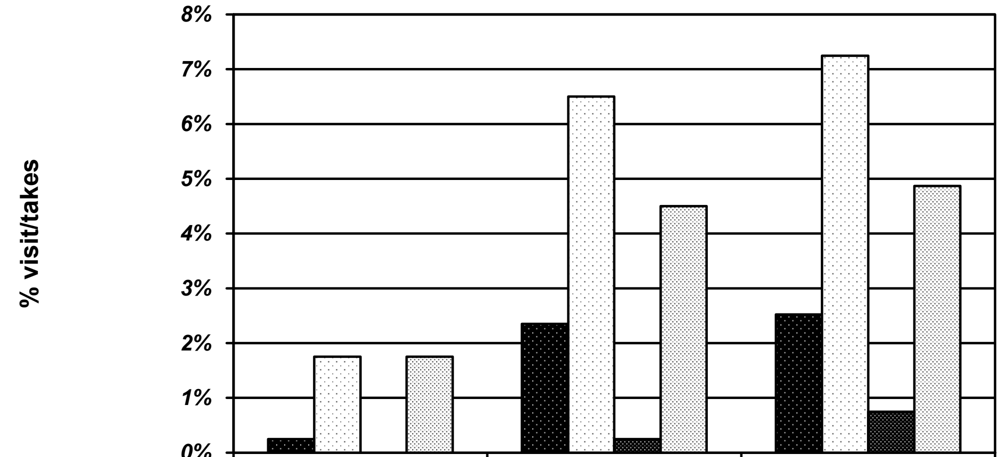


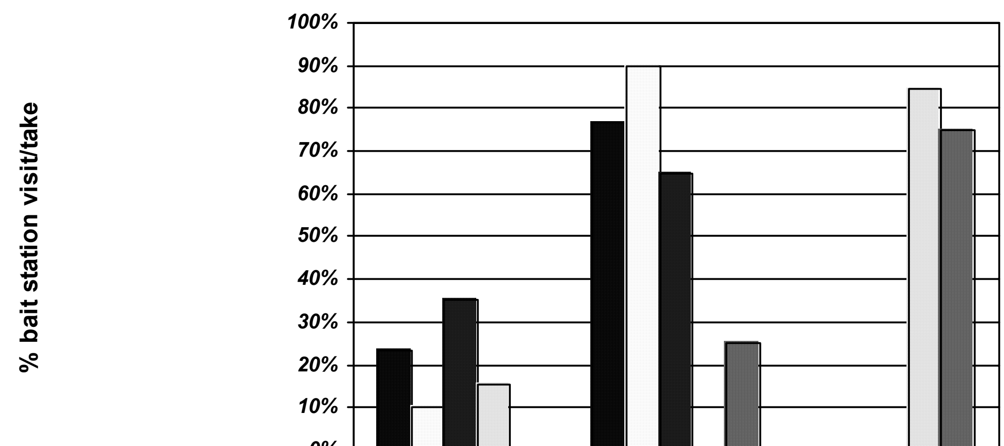
Figure 4. Bait takes for transects treated and untreated with pre-baits.

Table15. Percentage of visits/takes of total presentations



	Fox-Off®	Fox-Off®/SFE	Fox-Off®/SFE/pre-baited
fox takes	0.25%	2.35%	2.52%
fox visits	1.75%	6.50%	7.25%
wild dog takes	0	0.25%	0.75%
wild dog visits	1.75%	4.50%	4.87%

Table 16. Percentage of total bait station visit/take per treatment

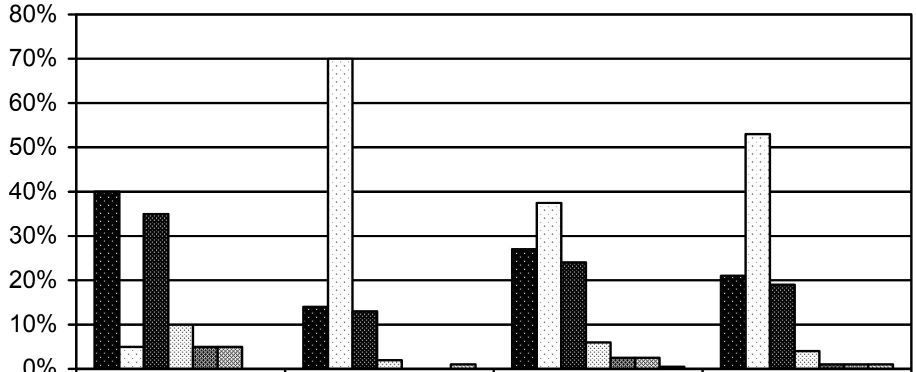


	Fox-Off®	Fox-Off®/SFE	Fox-Off®/SFE/pre-baited
fox visit (34) Namadgi 1	23.53%	76.47%	N/A
fox take (10) Namadgi 1	10%	90%	N/A
wild dog visit (34)	35.30%	64.70%	N/A
wild dog visit pre baited (46)	15%	N/A	84.78%
wild dog takes (8)	0.00%	25%	75%

Pre-baits

The Currango transect was pre-baited using synthetic fermented egg (SFE DRC-6503) applied to marshmallows.

Table 17. Pre-bait takes per species as % of take



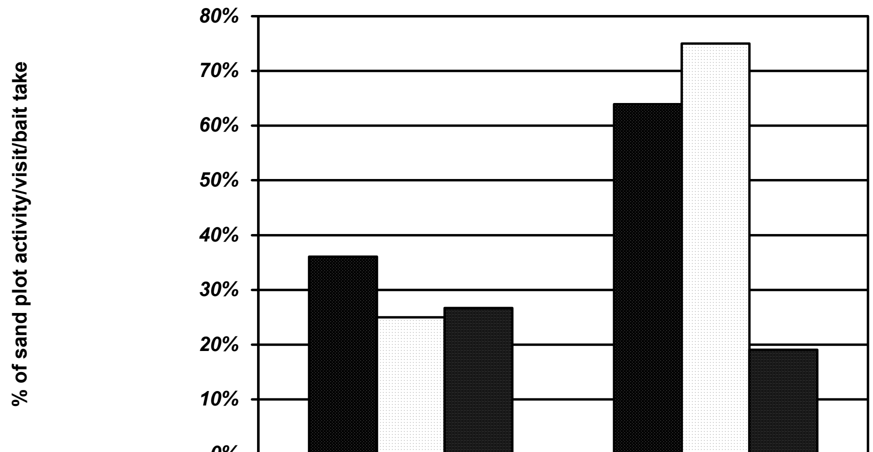
	Currango 1 (n=20)	Currango 2 (n=56)	average % take	Overall % take
wild dog	40%	14%	27.00%	21%
fox	5%	70%	37.50%	53%
bird	35%	13%	24.00%	19%
rabbit	10%	2%	6.00%	4%
horse	5%	0%	2.50%	1%
pig	5%	0%	2.50%	1%
possum	0%	1%	0.50%	1%

Pre-bait takes by wild dogs decreased from Currango 1 (40%) to Currango 2 (14%) with an increase in fox pre-bait takes from Currango 1 (5%) to Currango 2 (70%). The Currango 2 monitoring period was identified via the sand plot monitoring as having greater park user presence than Currango 1. The increase in park user disturbance correlates with an increase in fox presence, a decrease in wild dog presence and an increase in pre bait-takes and bait station attendance and takes by foxes on the Currango transect.

Black and tan wild dog moving in to FeralMone™ treated pre-bait (photo Rob Hunt)

Pre-baits were consistently taken by foxes (overall take 53%) wild dogs (overall take 21%) and birds (overall take 19%) during Currango 1 and 2. Rabbits removed 3 pre-baits while wild horses, feral pigs and possums removed a single pre-bait each during the combined Currango 1 and 2 period. Ants varied in their level of presence but were found upon all pre-baits during Currango 1 and 2.

Table 18. Percentage of wild dog visit/bait take to SFE treated bait stations with percentage of sand plot activity



	Fox-Off®/SFE	Fox-Off®/SFE/pre-baited
■ *wild dog visit (n=61)*	*36.07%*	*63.93%*
□ *wild dog take (n=8)*	*25%*	*75%*
■ *% sand plot activity*	*26.66%*	*19.07%*

Pre-baiting on the Currango transect coincided with increased site visitation to treated bait stations (n=39) when compared to treated bait station visitation by wild dogs at the Namadgi transect (n=22), where no pre-baiting was undertaken. The number of bait station takes by wild dogs on the Currango pre-baited transect (n=6) was also higher than wild dog takes on the Namadgi transect (n=2) where pre-baiting was not carried out. Although wild dog bait station visitation and takes were higher on the Currango transect where pre-baiting was carried out, the percentage of wild dog activity at Namadgi (non-pre-baited) was higher (26.66%) than wild dog activity recorded on sand plots for the Currango (pre-baited) transect (19.07%).

Remote cameras
The use of remote cameras allowed the identification of individual wild dogs along the Currango and Namadgi transects. The high number of unauthorised vehicles using the Currango transect restricted the opportunity to utilise the cameras for extended periods, with monitoring being restricted due to the danger of camera theft or vandalism.


wild dogs Yaouk Trail Namadgi NP (photos Rob Hunt)


Murrays Gap Trail Namadgi NP (photo Rob Hunt) **Lick Hole Trail Namadgi NP** (photo Rob Hunt)


wild dog Yaouk Trail Namadgi NP (photos Rob Hunt)

Discussion

The application of a formulation of Synthetic Fermented Egg (SFE DRC-6503) to the surface of bait stations significantly increased site visitation by wild dogs and foxes when compared to the use of buried commercial Fox-Off® baits alone. The increase in bait uptake by foxes to SFE treated bait stations was highly significant when compared to bait uptake at untreated stations, although this effect diminished with time, possibly due to the use of non-lethal baits leading to the eventual discovery of all bait stations and habituation of animals to sites of reward. Bait uptake by wild dogs, although limited to a total of 8 instances, occurred only at those bait stations treated with SFE, and was statistically significant.

The ability to safely and effectively administer a standard dose of SFE to bait stations via an aerosol can is a significant achievement in the field of canid control and management. The ease of application, consistent scent quality, high level of operator safety and extended shelf-life of synthetic scents will ultimately benefit the effectiveness of canid management operations. Further benefit may be achieved if this material can be linked with further research on bait palatability and pre-baiting.

Without the application of radio transmitters in baits, which was not possible as part of this study, the ultimate fate of baits taken from bait stations can not be determined. The application of SFE to bait stations within a lethal control program should be undertaken to build on the results shown here. Lethal canid management areas currently being monitored with sand plots exist within south-east NSW and should be utilised to further evaluate the results of this field trial.

Control of wild dogs and foxes by baiting requires that a series of steps be completed by the target animal. The initial process of luring the target animal to a point within the landscape is the first stage in bait uptake, but may be all that is required for an experienced trapper. Secondly, the animal must excavate or uncover the bait. Thirdly, the target animal must extract the bait from the bait station. Finally, the target animal must ingest the bait. Unfortunately at any stage of this bait uptake process individual animals may fail to progress to the next bait uptake stage, depending on a number of factors. Thus, seasonality, breeding cycle, bait palatability, disturbance on trails, previous ingestion of a sub-lethal bait, weather conditions and prey abundance may all play a part in determining whether the target animal progresses through the entire bait uptake process.

The application of SFE to bait stations has been shown here to significantly increase site visitation by both wild dogs and foxes. This result alone may be sufficient to increase trap success, however, it is only the first stage of the bait uptake process. The increase in fox bait uptake on SFE bait stations is encouraging, however it is possible that many of those baits were cached, as has been shown in previous studies (Saunders *et al*. 1999, von Polanan Petel *et al*. 2001, Thomson and Kok 2002).

Alternatively the high visitation rate to bait stations treated with SFE, coupled with a more palatable bait coating, may allow a reduction in the number of lethal bait presentations required during canid management programs. This in turn may limit the occurrence of caching, the possible impact upon non-target animals, the ingestion of sub-lethal doses and ultimately bait aversion by the target animal.

The palatability of baits has been documented as an important factor in bait consumption (von Polanan Petel *et al*. 2001) with less palatable baits likely to be cached by foxes. This practice can then lead to other target animals ultimately ingesting sub-lethal doses which may result in bait-shy individuals. Liaison with field specialists (B. Morris, A. McDougall, M. Clarke, M. Davis *pers comm.*) has identified that in many cases wild dogs and foxes excavate and remove baits from bait stations, but often reject baits within close proximity to where they were found.

The use of sweet unpoisoned pre-baits (e.g.marshmallows) utilising the same scent as that used at the control site has been proven to increase site visitation and activation rates of M-44 coyote control devices in the U.S. (Fall and Mason 2002). Marshmallows treated with SFE were used as part of this trial in an attempt to increase bait uptake as a result of target animals consuming pre-baits and actively seeking the target scent after 'positive reinforcement' of the scent. Although the amount of data relating to wild dog and fox pre-bait visits and takes was not sufficient to allow a full data analysis, an interesting trend emerged which warrants further investigation. Pre-baiting on the Currango transect coincided with increased site visitation and bait uptake from SFE bait stations when compared to visitation and takes by wild dogs at SFE stations on the Namadgi transect. This observation is of particular interest as higher visitation and bait uptake was recorded for the pre-baited site despite a lower wild dog abundance rating than that recorded for the non pre-baited site. This observation suggests that further research on pre-baiting could ultimately improve control practices for foxes and wild dogs in Australia.

The use of marshmallows as pre-baits for future studies appears limited due to issues relating to their removal from pre-bait sand pads by birds and their high palatability to ants, which may reduce their attractiveness to target animals. Of the 6 wild dog takes on the pre-baited transect four were found to have the treated marshmallow removed from the centre of the bait with the remaining commercial bait matrix left beside the bait station. This behaviour once again highlights the need to investigate opportunities to habituate target animals to scents which have been positively reinforced at a location remote from the bait presentation site. Further work is required on bait coatings.

This trial also identified a major increase in site attendance and bait take by foxes for the second monitoring period on both the Currango and Namadgi transects. This result highlights a possible link in the behavioural response of foxes habituated by attending sites of previous food reward. In effect this study identified fox response to two forms of pre-baiting, 'landscape pre-baiting' where scented food rewards are used across a landscape, remote from specific sites of control, and 'point of control' pre-baiting where 'free feed' or unpoisoned baits are used at control points prior to the use of lethal baits. A comparison of the benefits of both 'pre-baiting' approaches requires further investigation.

Use of SFE in areas of high quality quoll habitat should be undertaken with caution until completion of studies on the response (if any) of quolls to SFE, and their resulting behaviour when exposed to bait stations treated with synthetic fermented egg. In areas where quolls are known to occur the attractant could be placed adjacent to the bait station to limit the likelihood of quolls digging for baits (J. Durrant *pers comm*.) however recent research in Tasmania is encouraging, with quolls and Tasmanian devils showing little or no interest in FeralMone™ (S. Lapidge *pers comm*.) Further research is required.

The high number of pre-bait takes by birds may have occurred due to the attraction of birds to the raked sand plots (Dexter and Meek 1998, Thomson and Kok 2002). The future use of pre-baits would involve baits being broadcast across areas of vegetative cover adjacent to trails, where birds would be less likely to locate and consume or relocate pre-baits. Use of a larger pre-bait with a more hardy coating would also make consumption or movement of pre-baits more difficult for birds. In any event pre-baits are unpoisoned baits treated to condition canids to actively seek similar scents after positive reinforcement has taken place. Birds were not found to dig for baits within bait stations as a result of consuming pre-baits.

The application of SFE lure to marshmallows also required a significant investment of labour, with much of the agent being wasted. The development of a more hardy, sweet-tasting, scented coating for existing commercial baits should be investigated. The application of a sweet tasting, SFE-scented, hard coating to existing commercial baits is likely to increase bait palatability, especially if unpoisoned commercial baits were able to be used as pre-baits where required.

The ability to link a more effective pre-bait with a proven scent delivery method may ultimately assist with addressing the predation of domestic stock by wild dogs across the landscape. Traditionally wild dog management in south east Australia has relied upon the implementation of lethal control programs located in timbered country adjoining areas of domestic stock. The opportunity may now exist for the implementation of a broad scale solution to this landscape scale issue.

Wild dogs in core bushland areas are currently subject to intense pressure from rural communities and farming organisations proposing lethal control activities across all areas of wild dog/dingo habitat. Such an approach is cost prohibitive and likely to be limited in its success if implemented using existing control methods. Wild dogs in core bushland areas undertake top order predator functions regardless of their genetic make up (Daniels and Corbett 2003), and prey upon large native and introduced herbivores, which would otherwise be subject to little predator pressure.

An opportunity may exist for core areas of bushland to be regularly treated with pre-baits to establish a 'positive reinforcement' to SFE from the uptake of sweet unpoisoned surface baits. Dispersing wild dogs which associate the scent of SFE with a positive experience would then be more likely to investigate a control site treated with the same material. Field specialists equipped with SFE aerosol cans, sweet-coated pre-baits and lethal baits would continue to operate within agreed lethal control zones where wild dogs and foxes may also be pre-baited to increase bait uptake and trap site attendance.

Field specialists (trappers/doggers/bait station operators) involved in wild dog and fox management often cover large areas of bushland at variable times of the year. The intermittent management of these areas is often dictated by the availability of resources rather than the abundance, activity or impact of the target species. The ability of these specialists to broadcast "free baits" during and upon leaving areas of control may enhance future control activities by habituating target animals which take up residence whilst control operations are absent. Such an approach may significantly increase the effectiveness of control methods when they are re-applied.

Implementing such a management program would allow effective management of wild dogs to be undertaken, from the site of sheep attacks, across the landscape to core bushlands areas where stable wild dog packs could continue to fulfil their function as top order predators. Such a management approach must also be matched by continued development of both lethal and non-lethal control methods at points of attack, and in adjacent bushland.

The opportunity to implement suitably resourced field studies in close collaboration with private and public land managers, field specialists (trappers/doggers) and research professionals will continue to ensure the provision of on-ground results which enhance the long term management of the impacts of wild dogs and foxes.

Recommendations

- **Continue SFE bait station trials within an established lethal control program**
- **Develop partnerships to commercially supply SFE in aerosol cans**
- **Investigate a hardy, sweet, SFE scented bait coating to increase palatability of baits for lethal and pre-baiting operations**
- **Establish pre-baiting trials (landscape vs point of reward) in areas of core bushland remote from wild dog control operations**
- **Undertake SFE non-lethal/non-target trials within quoll habitat**

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Permits and animal ethics
This study was carried out under:
- NSW National Parks & Wildlife Research Consent No. RC 01/2003
- Department of Environment and Conservation Animal Ethics permit No. 031215/05: and
- ACT Parks & Conservation Namadgi Research Permit No. 358.

Appendix One

Statistical analysis
The visit and take data was analysed using a generalised linear mixed model (McCulloch and Searle 2001). This analysis was chosen due to the nested nature of the study design. Preliminary analysis determined that the dog data was two sparse for detailed modelling to be undertaken. These will be returned to later in the Appendix. For the fox data the data was modelled as a binary outcome (Yes/no) and the following model was fitted.

Logit(p)= habitat+Rep+treatment+Rep:Treatment+day+visit.prev + Location1/station1

The variables in this formula are
habitat which has two values plain and timber,
Rep is one or two and signifies which repetition of the experiment
Treatment denotes whether the station was scented or not scented
Rep:Treatment is the interaction term and allows the effect of the treatment to vary between repetitions.
Day is the number of the day in the sequence, and is modelled as a factor
Visit.prev = 0 if the station was not visited by a fox the previous day and one otherwise.

The random effects in the model were Location which had two values, namadgi or currango, and Station1, which denoted the station numbers. The / in the formula signifies a nested effect. A day to day effect was included initially but its effect was small and it was dropped. In words the model takes into account that some stations are inherently visited more than other stations and that the background number of animals varies from Location to location and rep to rep.

Backwards stepwise elimination was performed to select the final model. The output from fitting the model in R using glmmPQL was as follows:

```
Random effects:
 Formula: ~1 | Location1
        (Intercept)
StdDev:   0.4946764

 Formula: ~1 | station1 %in% Location1
        (Intercept) Residual
StdDev:   0.5230176 1.082807

Variance function:
 Structure: fixed weights
 Formula: ~invwt
Fixed effects: visit.fox ~ Rep * treatment + day +
visit.fox.prev1
                    Value Std.Error   DF   t-value p-value
(Intercept)     -3.500340 0.5211505 1507 -6.716562  0.0000
Rep2             1.902858 0.2577771 1507  7.381796  0.0000
treatment2      -0.874863 0.3995231   77 -2.189768  0.0316
```

```
day2            -0.246420 0.4441971 1507 -0.554755  0.5791
day3             0.359988 0.4062853 1507  0.886047  0.3757
day4             0.696591 0.3944014 1507  1.766197  0.0776
day5             0.864182 0.3915753 1507  2.206938  0.0275
day6             1.662328 0.3798689 1507  4.376056  0.0000
day7             1.516098 0.3879186 1507  3.908289  0.0001
day8             0.518438 0.4107373 1507  1.262214  0.2071
day9             0.142895 0.4192116 1507  0.340867  0.7333
day10            1.437051 0.3823213 1507  3.758753  0.0002
day11            0.378958 0.5705197 1507  0.664234  0.5066
visit.fox.prev1  0.396072 0.1932321 1507  2.049721  0.0406
Rep2:treatment2  0.765474 0.4185384 1507  1.828921  0.0676
```

To test for the overall day effect we use an anova:

```
anova(model,model1)
       Model df     AIC      BIC    logLik   Test  L.Ratio p-value
model      1 18 8897.06 8993.859 -4430.530
model1     2  8 8220.05 8263.072 -4102.025 1 vs 2 657.0103  <.0001
```

As expected there is significant variation between locations and between stations. The Day effect is highly significant and is plotted in figure 1. There is significant effect for the treatment, and strong evidence for an interaction between the treatment and the repetition. The scent treatment significantly increases the probability of visit, and there is a large significant increase in visitation on the second repetition. The interaction term, while not statistically significant gives evidence that the use scent is less effective in the second rep. This could potentially be explained by animals learning where the stations are. There is a significant effect for visit on the previous day, which suggests that foxes learn the location of the stations and actively return to them.

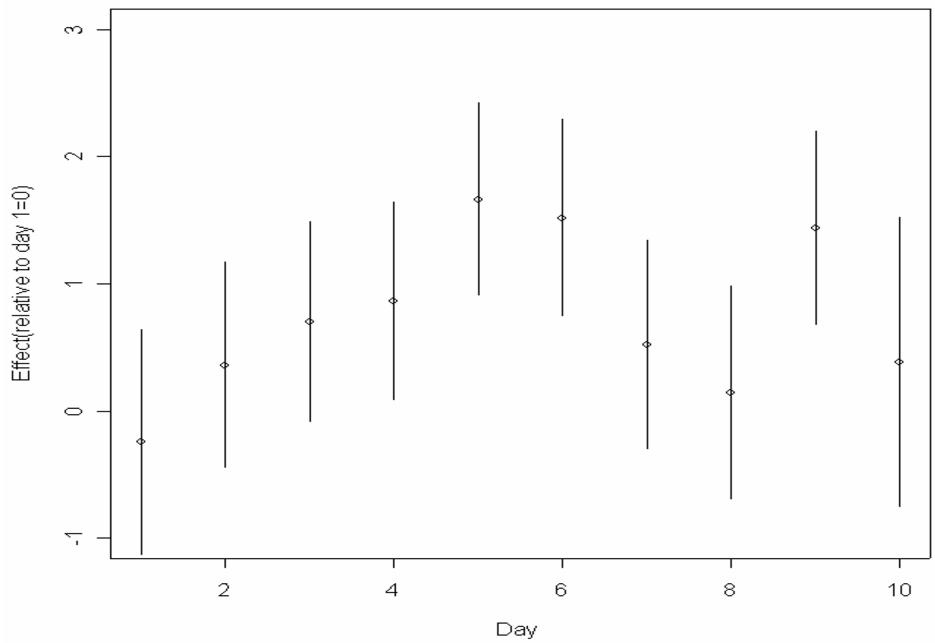

Figure 1 Day effects with approximate 95% confidence intervals

The analysis was repeated for the take data:

```
Linear mixed-effects model fit by maximum likelihood
 Data: all.data
       AIC      BIC    logLik
  12048.29 12141.19 -6006.145

Random effects:
 Formula: ~1 | Location1
        (Intercept)
StdDev:    1.134520

 Formula: ~1 | station1 %in% Location1
        (Intercept)  Residual
StdDev:    1.517913 0.6459074

Variance function:
 Structure: fixed weights
 Formula: ~invwt
Fixed effects: take.fox ~ treatment * Rep + day +
visit.fox.prev1
                     Value Std.Error   DF   t-value p-value
(Intercept)      -7.221937      0.97 1195 -7.457793  0.0000
treatment2       -2.572359      0.81   77 -3.169237  0.0022
Rep2              3.744750      0.33 1195 11.356031  0.0000
day2             -1.410966      0.73 1195 -1.929110  0.0540
day3              1.762897      0.38 1195  4.657201  0.0000
day4              1.816879      0.41 1195  4.439991  0.0000
```

```
day5              3.030102      0.41 1195  7.388096  0.0000
day6              3.959207      0.39 1195 10.075231  0.0000
day7              3.360536      0.43 1195  7.752135  0.0000
day8              1.306534      0.80 1195  1.630405  0.1033
day9            -20.842141  27225.55 1195 -0.000766  0.9994
day10             3.896599      0.50 1195  7.857914  0.0000
day11           -21.864934  74366.00 1195 -0.000294  0.9998
visit.fox.prev1  -0.755541      0.29 1195 -2.567513  0.0104
treatment2:Rep2   2.418043      0.76 1195  3.182903  0.0015
```

For day effect:

```
> anova(model,model1)
       Model df       AIC       BIC    logLik   Test  L.Ratio p-value
model      1 18 12048.290 12141.186 -6006.145
model1     2  8  8247.598  8288.885 -4115.799 1 vs 2 3780.693  <.0001
```

Note there was divergence of parameter estimates due to sparse data. Patterns in this data are similar to in the visit data, with the treatment effect more pronounced.

Several other analyses where done. For dogs, all 8 bait takes occurred at scented stations. From binomial theory, the probability of this occurring by chance if each take was an independent event and there were no significant differences between the stations is .004. Given that all takes occurred in widely separated stations we can have some confidence in this result. Thus there is evidence of a scent effect for dogs. The visit data for dogs gives 18 visits to unscented and 61 to scented stations. Again assuming independence the chance of as extreme or more extreme result (ie less than 18 out of 78 visits) is <10-6 which gives strong evidence of a day effect.

To compare the pre baiting effect it was not possible to test it statistically given the lack of replication. Instead we graphically present the visit rate(visits/station/day) standardized by the sand plot activity(total prints, which represents an independent estimate of animal activity) for each location and repetition. This is presented in figure 2.

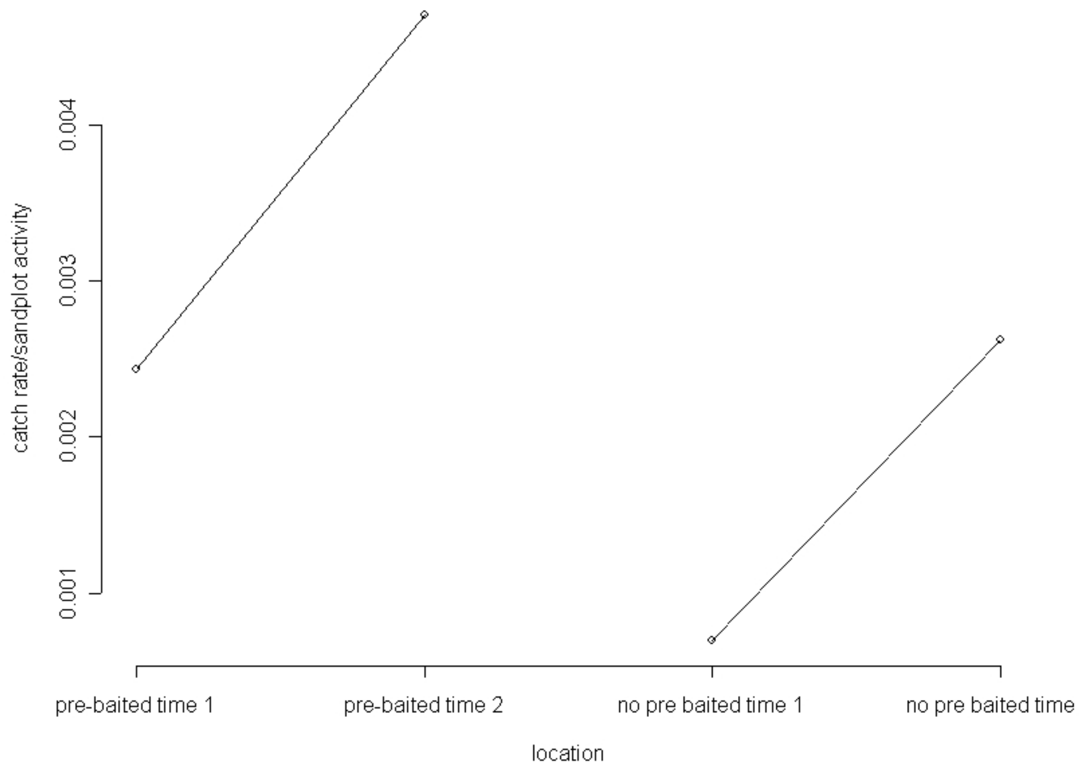

Figure 2

Note that the pre-baited sites have a higher visitation rate initially.

References

Allen, L., Engeman, R. and Krupa, H. (1996) Evaluation of three relative abundance indices for assessing dingo populations. *Wildlife Research*, **23:** 197-206.

Blom, S. (1989) *A guide to ingredients and formulations used for coyote lures and baits* Denver Wildlife Research Center Colorado July 1989 Revised July 1990.

Blom, S. (1994) *Ingredients for coyote attractants: functions and uses.* Pocatello Supply Depot, Idaho. U.S. Department of Agriculture.

Bullard, R.W.,Turkowski, F.J. and Kilburn, S.R. (1983) Responses of free-ranging coyotes to lures and other modifications. *Journal of Chemical Ecology*, Vol 9: 877-888.

Catling, P. and Burt, R.(1994). Studies of the Ground-dwelling Mammals of Eucalypt Forests in South-eastern New South Wales: the species, their Abundance and Distribution. *Australian Wildlife Research* **22:** 535-546.

Catling, P. and Reid, A.(2004). Predator and Critical Weight Range Species Monitoring in the South-West Slopes Region. CSIRO Sustainable Ecosystems, Canberra.

Daniels, M. and Corbett, L.(2003). Redefining introgressed protected mammals: when is a wildcat a wild cat and a dingo a wild dog? *Australian Wildlife Research* **30:** 213-218.

Dexter, N. and Meek, P.(1998). An analysis of bait-uptake and non-target impact during a fox-control exercise. *Australian Wildlife Research* **25:** 147-155.

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

Fall, M.W. and Mason, J.R., (2002) Developing methods for managing coyote problems – another decade of progress, 1991-2001. In *Proceedings 20th Vertebrate Pest Conference*.(ed. R.M. Timm and R.H. Schmidt) pp. 194-200. (University of California).

Fleming, P., Corbett, L., Harden, R. and Thomson, P. (2001) Managing the Impacts of Dingoes and Other Wild Dogs. Bureau of Rural Sciences, Canberra.

Hunt, R. and McDougall, A. (2002) Recommendations from coyote management study tour with U.S. Department of Agriculture, Wildlife Services, Utah. (NSW National Parks Service).

Hunt. R. (2002) Brindabella and Wee Jasper Valleys Cooperative Wild dog/fox control plan. (NSW Rural Lands Protection Board, NSW National Parks and Wildlife Service and NSW State Forests).

Jolly, S.E. and Jolly, M.E. (1992) Pen and field tests of odor attractants for the dingo. *Journal of Wildlife Management* **56:** 452-456.

Kimball, B.A., Mason, J.R., Blom, F.S., Johnston, J.J and Zemlincka, D.E. (2000) Development and testing of seven new synthetic coyote attractants. *Journal of Agricultural and Food Chemistry*, 48, (5) 1892-1897.

Kimball, B.A., Johnston, J.J., Mason, J.R., Zemlincka, D.E. and Blom, F.S. (2000) Development of chemical coyote attractants for wildlife management applications, In *Proceedings of the 19th Vertebrate Pest Conference* T.P. Salmon and A.C. Crabb, Eds. Pp 304-309. (University of California: Davis).

Lapidge. S.J (2004) A review of 30 years of canid attractant research. Pestat Limited. www.feral.org.au

Linhart, S.B., Dasch, G.J., Roberts, J.D. and Savarie, P. J. (1977) Test methods for determining the efficacy of coyote attractants and repellents. In *Test Methods for Vertebrate Pest Control and Management Materials*. ASTM STP 625, W.B Jackson and R.E. Marsh, Eds. American Society of Testing Materials, p 114-122.

McCulloch, C.E. and Searle,S.R. (2001) Generalized, Linear, and Mixed Models (2001) Wiley, New York.

Mason, J.R. and Bodencuck, M.J. Depredation management outside the box: Logical adaptations of successful practices with other species and situations. U.S. Department of Agriculture, Wildlife Services undated.

Mitchell, J. and Kelly, A. (1992). Evaluating odour attractants for control of wild dogs. *Australian Wildlife Research* **19:** 211-219.

Moss, Z.N., O'Connor, C.E. and Hickling, G.J. (1998) Implications of prefeeding for the development of bait aversions in brushtail possums, Trichosurus vulpecular. *Australian Wildlife Research* **25:** 133-138.

Phillips, R.L., Blom, F.S. and Engeman, R.M. (1990) Responses of captive coyotes to chemical attractants. *In Proceedings of the Vertebrate Pest Conference*. L.R. Davis and R.E. Marsh, Eds. Pp. 285-289. (University of California: Davis.)

Queensland Department of Natural Resources and Mines. (2003) Economic assessment of the impact of dingoes/wild dogs in Queensland.

Saunders, G., Coman B., Kinnear, J. and Braysher, M. (1995) 'Managing Vertebrate Pests: Foxes.' (Australian Government Printing Service: Canberra.)

Saunders, G. and Harris S. (2000) Evaluation of attractants and bait preferences of captive red foxes, Vulpes vulpes. *Australian Wildlife Research* **27:** 237-243.

Saunders, G., Kay, B. and McLeod, L. (1999) Caching of baits by foxes (Vulpes vulpes) on agricultural lands. *Australian Wildlife Research* **26:** 335-340.

Saunders, G., McLeod, S. and Kay, B. (2000) Degradation of sodium monofluoroacetate (1080) in buried fox baits. *Australian Wildlife Research* **27:** 129-135.

Thomson, P.C. and Kok, N.E. (2002) The fate of dried meat baits laid for fox control: the effects of bait presentation on take by foxes and non target species, and on caching by foxes. *Australian Wildlife Research* **29:** 371-377.

Turkowski, F.J., Popelka, M.L., Green, B.B. and Bullard, R.W. (1979) Testing the responses of coyotes and other predators to odor attractants. In 'Vertebrate Pest Control and Management Materials. (Ed. J.R. Beck) pp. 255-269. (American Society for Testing and Materials.)

von Polanen Petel, A.M., Marks, C.A. and Morgan, D.G. (2001) Bait palatability influences the caching behaviour of the red fox, *Vulpes vulpes*. *Australian Wildlife Research* **28:** 395-401.