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Development and Testing of a Deer-Repellent Cereal Bait for Possum Control

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Summary

Project and Client

Landcare Research, Lincoln, and Epro, Taupo, conducted a series of trials for the Animal Health Board, to assess the likely effectiveness of a potential deer repellent for reducing the incidental by-kill of deer during aerial poisoning of possums using cereal baits containing sodium monofluoroacetate (1080). The trials were conducted between September 2002 and July 2003 (Project R-80568).

Objectives

To develop and field test a cereal-based 1080 bait containing a deer repellent that is as effective at killing possums as conventional 1080 cereal pellets, but which reduces or eliminates any incidental deer by-kill, by:

- contracting a bait manufacturer to incorporate the repellent in trial amounts of cinnamon-lured and plain cereal baits
- determining the palatability of baits to farmed red deer and to captive possums
- determining the effect of the repellent on 1080 toxicity to captive possums
- determining the efficacy of repellent and non-repellent baits at killing possums in one field trial.

Methods

- Animal Control Products (ACP) was contracted to manufacture cereal bait incorporating deer repellent, and supply cereal bait with and without cinnamon lure to Epro for surface-coating with deer repellent.
- Six types of non-toxic cereal bait with various combinations of cinnamon lure, and/or the potential deer repellent incorporated or applied to the outer surface, were presented to intensively farmed red deer hinds or stags in separate 4-day trials. A second trial compared the consumption of four types of non-toxic cereal bait with and without deer repellent and cinnamon with extensively farmed deer.
- The effect of deer repellent on the palatability of non-toxic cinnamon-lured or unlured cereal bait to possums was compared using a choice test with 40 captive possums. The toxicity to possums of 0.15% 1080 cereal bait cinnamon-lured and unlured with and without deer repellent was also compared using 40 captive possums.
- The toxicity to wild possums of cinnamon-lured 1080 cereal bait with and without deer repellent was compared in two pairs of contiguous 500-ha blocks at Te Wera Forest, Taranaki.

Results

- Intensively farmed deer ate very little cereal bait when it was surface coated with the deer repellent (both with and without cinnamon lure), but ate all of the bait with no repellent or with the repellent incorporated. Stags ate the bait with no repellent and with the repellent incorporated faster than hinds. All subsequent trials therefore only used surface-coated baits.
- In the trial with more extensively farmed deer, little bait of any sort was eaten until the fourth day, but the stag group then ate significantly more non-repellent than repellent bait.

- The amount of cereal bait with and without deer repellent eaten by possums did not differ. There was no significant difference in mortality of samples of 10 possums given cinnamon-lured baits with the repellent (80% kill) and without the repellent (90% kill), or with unlured baits with the repellent (40% kill) and without the repellent (30% kill). Mortality was significantly lower when unlured bait was used.
- There was no difference in the residual density of possums remaining after field application of cinnamon-lured repellent-coated cereal bait at Te Wera (Residual Trap Catch Indices of 0% and 1.3 ± 1.7% in the two repellent blocks, compared to 0.3 ± 0.8% and 1.7 ± 1.7% in the two non-repellent blocks).

Conclusions

- The repellent successfully reduced consumption of cereal bait by farmed red deer, but only when applied to the outer surface, and regardless of whether cinnamon lure was included.
- Low mortality rates for penned possums when unlured bait was used (both with and without repellent) suggests it would be advisable to use a lure with the repellent-coated cereal 1080 bait, at least until the generality of this finding is confirmed.
- Overall, these trials suggest that deer repellent could reduce the incidental by-kill of deer in aerial 1080 cereal operations without reducing possum kills.

Recommendation

- The AHB should proceed with formal field trials with cereal bait to confirm that the repellent significantly reduces the incidental by-kill of wild deer.

1. Introduction

Landcare Research, Lincoln, and Epro, Taupo, conducted a series of trials, for the Animal Health Board, to assess the likely effectiveness of a potential deer repellent for reducing the incidental by-kill of deer during aerial poisoning of possums using cereal baits containing sodium monofluoroacetate (1080). The trials were conducted between September 2002 and July 2003 (Project R-80568).

2. Background

The incidental killing of deer during aerial 1080 poison operations targeting possums is of concern to hunters, pest control officers, and some members of the general public. Estimates of the deer by-kill during such operations have ranged from zero to 93% (Nugent et al. 2001). Recent work in the Blue Mountains, Otago, estimated that 66–75% of fallow deer (*Dama dama*) in the poison area were likely to have been killed (Nugent & Yockney 2002). One way to reduce the deer by-kill is to reduce the attractiveness of toxic bait to deer, something that could be achieved by adding to the bait a substance repellent to deer, but not possums. Trials by Landcare Research for Epro in 2001/02 identified a suitable repellent for use on carrot bait (Forsyth 2002), and this has shown some promise in subsequent field trials at Hampden, Otago, in 2002 (Lorigan et al. 2002) and in a current trial at Pohokura, Hawke’s Bay (Nugent unpubl. data). The purpose of this study is to determine if this repellent could also be used on cereal bait, the bait type most commonly used for aerial 1080 possum control.

3. Objectives

To develop and field test a cereal-based 1080 bait containing a deer repellent that is as effective at killing possums as conventional 1080 cereal pellets, but which reduces or eliminates any incidental deer by-kill, by:

- contracting a bait manufacturer to incorporate the repellent in trial amounts of cinnamon-lured and plain cereal baits
- determining the palatability of baits to farmed red deer and to captive possums
- determining the effect of the repellent on 1080 toxicity to captive possums
- determining the efficacy of repellent and non-repellent baits at killing possums in one field trial.

4. Methods

4.1 Formulation of trial bait types

Animal Control Products (ACP), Wanganui, was contracted to supply No. 7 cereal bait in two types: one with cinnamon lure, and one without. One batch of each type had the deer repellent incorporated by ACP at a rate of 6 kg of repellent per tonne of pellets. A second batch of each type was surface-coated with repellent by Epro. A third batch of each type was left repellent-free. All bait was dyed green. The resulting bait types were as follows:

1. Green-dyed non-toxic No. 7, unlured, no repellent.
2. Green-dyed non-toxic No. 7, lured (cinnamon), no repellent.
3. Green-dyed non-toxic No. 7, unlured, with repellent incorporated.
4. Green-dyed non-toxic No. 7, lured (cinnamon), with repellent incorporated.
5. Green-dyed non-toxic No. 7, unlured, with repellent applied externally.
6. Green-dyed non-toxic No. 7, lured (cinnamon), with repellent applied externally.

4.2 Repellency to intensively farmed deer

Initial testing was conducted with red-type (*Cervus elaphus*) deer at the Lincoln University Deer Research Unit, Lincoln, in October 2002. Because the deer were at high density and had been handled frequently, the farm is termed ‘intensive’. Separate trials were conducted with a hind-calf group (n = 25 hind-calf pairs) and stags (n = 27) in different paddocks. In each paddock, 2 kg of each of six bait types were placed in purpose-built wooden feeding troughs spaced about 2 m apart in clusters of six, with six clusters spread randomly across the paddock but with at least 10 m between clusters. Within clusters, bait types were distributed in a random block design. The amount of cereal pellet remaining was weighed at 4, 8, 24, 48, 72 and 96 h. Two troughs of each bait type were placed in a deer-free paddock nearby to correct for changes in pellet weight due to changing moisture content.

4.3 Repellency to extensively farmed deer

After initial results showed low consumption of both lured and unlured bait that had been surface-coated with repellent, a further trial was conducted at a comparatively ‘extensive’ deer farm (Heatherlea Deer Park, Hororata) where deer densities were lower, the paddocks and deer group size were larger, and the deer were handled less frequently than those in the first trial. These deer had no prior experience of cereal pellets, although they had been fed grain during the previous winter. In December 2002 a group of 150 stags 2 to 3 years old in a 10-ha paddock and a group of 192 rising yearling hinds in a separate 10-ha paddock were offered four bait types. The two bait types with the repellent incorporated into the bait were not included in this trial because they failed to repel deer, so only four bait types were tested. A total of 18 clusters of four troughs each were placed randomly through the paddocks (nine clusters in each paddock), as in the previous trial, and three troughs of each bait type were placed in a deer-free paddock to correct for changes in moisture content. The amount of cereal pellet remaining was weighed at 4, 8, 24, 48, 72 and 96 h.

4.4 Repellency and toxicity to captive possums

To check that addition of the repellent did not negatively affect the primary purpose of the bait (killing possums) we tested bait palatability and toxicity using captive possums. Forty wild-caught adult possums were acclimatised for at least 4 weeks in individual cages (350 × 200 × 200 cm) in rooms maintained at 19 ± 5°C at the Landcare Research Animal Facility, Lincoln. Prior to the trial, possums had free access to water and specifically formulated cereal-based pellets (Weston Milling Co., Rangiora), which were supplemented with fruit and vegetables. Twenty possums were presented with a choice of 250 g of unlured bait with no repellent and 250 g of unlured bait surface-coated with repellent. A further 20 possums were presented with a choice of 250 g of lured (cinnamon) bait with no repellent and 250 g of lured bait surface-coated with repellent. The two bait choices available to each possum were presented in separate trays for 1 night and the weight of remaining bait was measured the following morning. Water was freely available during the trial. To correct for dehydration, three trays of each bait type were left in the room outside the cages and reweighed in the morning. A paired-comparisons *t*-test was used to determine if there was a statistical difference in the amount of treated and untreated cereal bait eaten.

To test whether the addition of deer repellent to cereal pellets seriously affected the toxicity of the bait to possums, a further 40 adult possums were captured and acclimatised for 4 weeks as above. Possums were randomly assigned to two groups (n = 20), one group to receive unlured bait and the other to receive cinnamon-lured bait. Half of each group received a single 12 g pellet bait treated with a nominal 0.15% 1080 and green dye without deer repellent; and the other half received the same bait surface-coated with deer repellent. Possums continued to have access to their normal food and water during the trial. Any remaining toxic bait was removed after 24 h and the amount of toxic bait eaten by individual possums recorded. Possums were checked twice daily until death or for 7 days. Time of death was recorded. This experiment was approved by the Landcare Research Animal Ethics Committee (02/11/02). Staff at the IANZ-accredited Landcare Research toxicology laboratory assayed the 1080 concentration of cereal baits with and without repellent. The statistical differences in the mortality between the four treatments that were caused by the application of repellent, or interactive effect of repellent, lure and toxin, were assessed using logistic regression.

4.5 Toxicity to wild possums

An aerial 1080 poisoning operation was carried out at Te Wera Forest, Taranaki. The area comprises pine plantation managed by New Zealand Forest Managers (NZFM). Approximately 2000 ha of this forest were divided into four blocks of 500 ha (Appendix 1). Two of the blocks were randomly selected for treatment with No. 7 cereal bait (cinnamon-lured, 0.15% 1080) surface coated with repellent, and the remaining two blocks were treated with standard No 7. cereal bait (cinnamon-lured 0.15% 1080). Cereal bait was applied at a rate of 3 kg/ha following prefeeding with non-toxic bait (2 kg/ha) 11 days before the toxic bait was sown. The repellent was also applied on the prefeed for the repellent blocks.

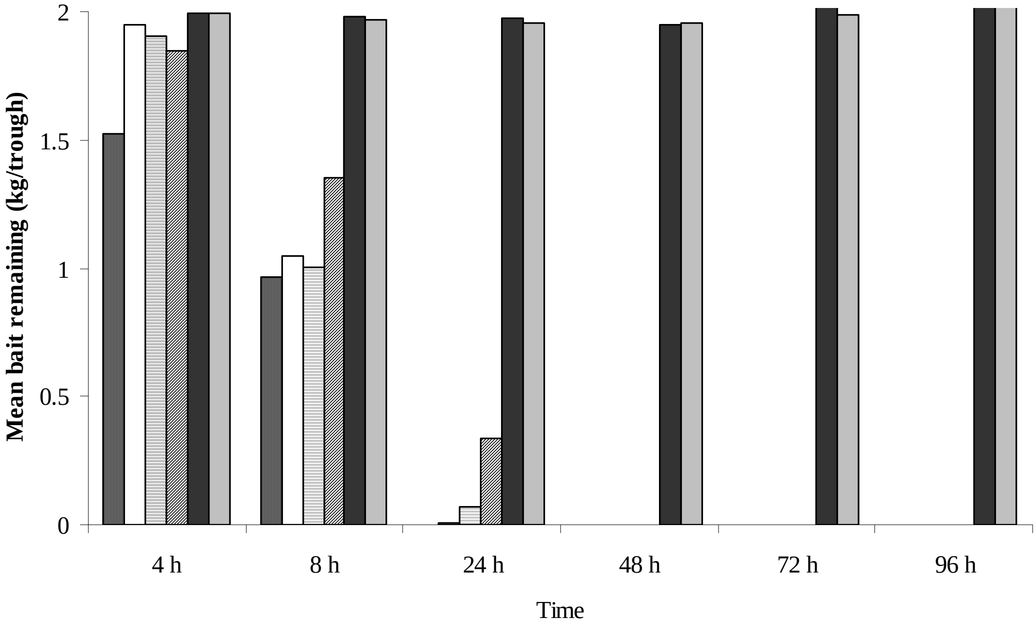
The change in possum density caused by poisoning was assessed using the Residual Trap Catch Index (RTCI), following the current nationally standardised protocol (NPCA 2001). Each of the four blocks had 10 paired trap lines (of 10 traps per line) placed at random start points. Pre-and post-control trap lines were at least 200 m apart, and lines were placed at least 150 m inside each block to minimise the potential for edge effects.

5. Results

5.1 Repellency to farmed deer: First trial

The deer ate all of the non-repellent and repellent-incorporated bait within 2 days, most of it within the first day. The consumption rate was slightly slower for the hind-calf group (Fig. 1a) despite the larger number of deer; the stags had eaten most of the bait within 8h (Fig. 1b). Surface-coated repellent bait was not eaten at all by the hind-calf group, and it appeared to repel the hinds and calves to the extent that grazing pressure near these troughs was reduced, resulting in a noticeable increase in the length of the grass over the four days compared to the rest of the heavily grazed paddock. The stag group did eat a very small amount of the unlured surface-coated repellent bait after 3 days. They also ate about half the cinnamon-lured surface-coated repellent bait on the first day (once all untreated and repellent-incorporated bait was gone), and most of the remainder of this bait type after 3 days. Light rain fell after 3 days, so the increased consumption after that may be linked to that event. Based on these results, no further testing was done of bait types with the repellent incorporated.

(a)



(b)

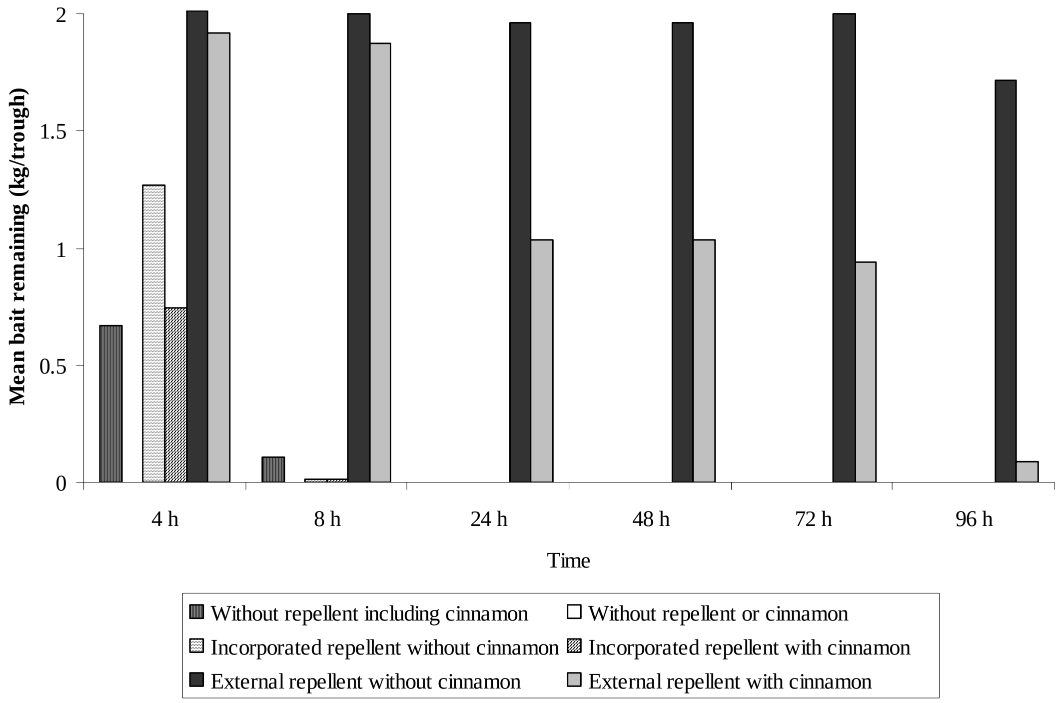


Fig. 1. Amount (kg/trough) of bait left by (a) red deer hinds and calves (*n* = 25 pairs) and (b) red deer stags (*n* = 27) at the Lincoln University Deer Research Unit. Troughs initially contained 2 kg of bait.

5.2 Repellency to farmed deer: Second trial

The hind group did not eat any of the four bait types at all. The stag group did not eat any of the bait until after the third day, but then ate approximately a quarter of the non-repellent bait available to them, and a small amount (<5%) of the two types of repellent bait (Fig. 2). The much lower consumption of bait in this trial may reflect the abundance of lush spring pasture in the trial paddocks at the time the trial was undertaken.

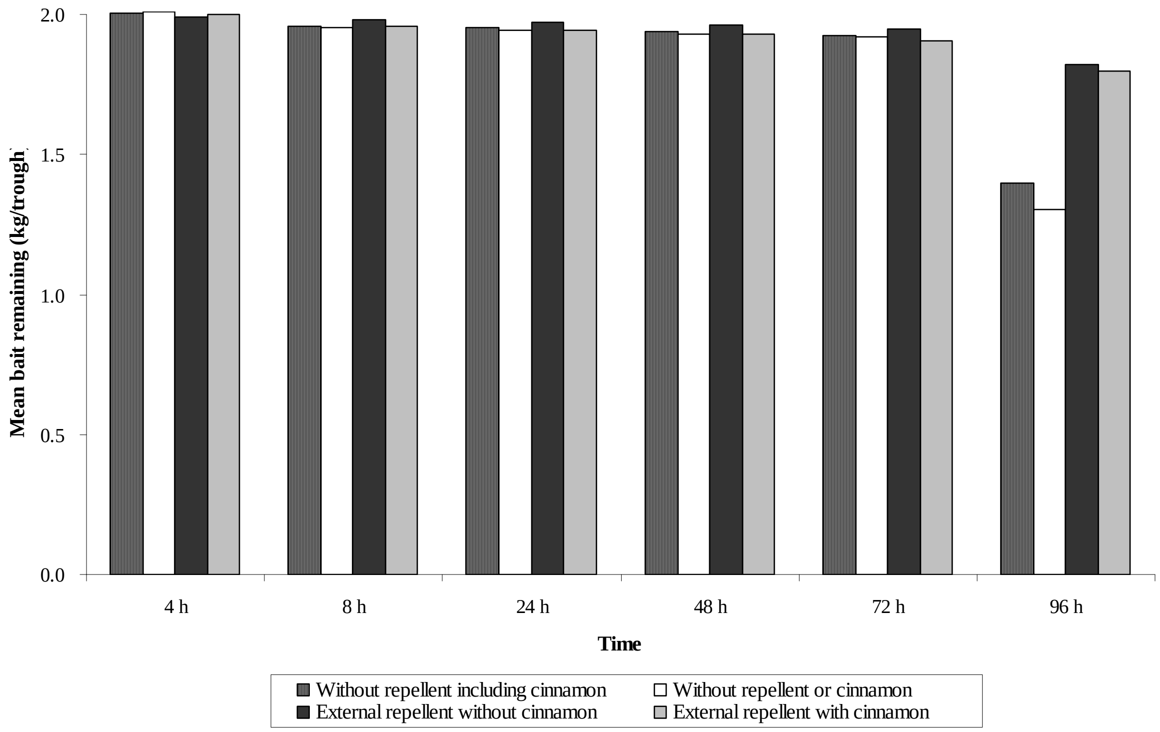


Fig. 2. Weight (kg/trough) of bait left by red deer stags (n = 175) at Heatherlea Deer Park, Hororata. Troughs initially contained 2 kg of bait.

5.3 Repellency and toxicity to captive possums

The 20 caged possums given cinnamon-lured cereal bait ate more of the bait that had been surface-coated with repellent (mean of 42 ± 15 g (SE)) than of non-repellent bait (27 ± 9 g) but the difference was not significant (Paired t-test, t = 1.37, d.f. = 19, P = 0.187). Eighteen of the 20 possums ate greater than 6 g of the repellent-coated bait, which suggests most of these would have been killed if the bait contained 0.15% 1080 (Henderson et al. 1999).

The 20 caged possums given unlured cereal bait ate more of the non-repellent bait (44 ± 15 g) than the bait surface coated with repellent (35 ± 14 g), but again the difference was not statistically significant. (Paired t-test, t = 0.73, d.f. = 19, P = 0.475). Fourteen of the 20 possums ate greater than 6 g of the repellent-coated bait.

For the two groups of 10 possums each offered single unlured 0.15% 1080 cereal baits, three in the non-repellent group died, compared with four from the surface-coated-repellent group. All of the surviving possums had eaten some bait (0.5–7.3 g) but not enough for a lethal dose. For the two groups of 10 possums each offered single cinnamon-lured, 0.15% 1080, cereal baits, nine in the non-repellent group died, compared with eight in the surface-coated-repellent group. One possum in the repellent group did not eat any bait, but the remaining two (one in each group) had eaten sub-lethal doses (0.6 and 0.4 g).

Addition of the repellent had no effect on toxicity or palatability of the baits to possums ($X^2_1 < 0.01$, $P = 0.99$). However, mortality was significantly lower when unlured bait was used ($X^2_1 = 11.03$, $P < 0.001$). There was no evidence that there were any interactive effects between the repellent and the cinnamon lure ($X^2_1 = 0.62$, $P = 0.43$).

The assayed concentration of 1080 in each bait type was as follows:

Cereal bait without cinnamon or repellent	0.12%
Cereal bait with repellent and without cinnamon	0.12%
Cereal bait with repellent and with cinnamon	0.14%
Cereal bait without repellent and with cinnamon	0.13%.

5.4 Toxicity to wild possums

High percentage kills and low residual possum densities were achieved in the possum field trial with both repellent and non-repellent 1080 bait (Table 1). There was no measurable difference in kills between the treatments.

Table 1: Pre- and post-control RTCIs and percent kills in contiguous 500-ha blocks of pine forest at Te Wera, Taranaki, in June 2003.

Block	Treatment	Pre (± CI)	Post (± CI)	% Kill
A	Non-repellent	25.2 ± 7.2	0.3± 0.8	98.7
C	Non-repellent	21.9 ± 4.6	1.7± 1.7	92.4
B	Repellent	20.1 ± 3.6	0	100.0
D	Repellent	21.7 ± 7.0	1.3± 1.7	93.9

6. Conclusions

Applying the repellent to the outside of cereal baits reduces the consumption of non-toxic bait by farmed deer, without any apparent effect on the consumption of those baits, or such baits containing toxin, by captive or wild possums. This result closely parallels the result achieved using carrot bait (Forsyth 2002). The low consumption of cereal bait even without repellent in the second trial suggests that cereal bait might not be particularly attractive to deer, at least when such baits are encountered for the first time and when other food (in the form of lush spring pasture) is abundant.

The trials with captive possums indicate, firstly, no significant statistical effect of the repellent on the palatability of non-toxic cereal bait to possums. Secondly, the cage trial with toxic baits showed that the repellent had no effect on possum mortality. Thirdly, the field trial showed no reduction in the percentage kill when the repellent was used. Collectively, these results indicate that the efficacy of 1080 poisoning of possums with cereal bait is unlikely to be adversely affected by use of this deer repellent, again paralleling the results with the repellent carrot bait (Lorigan et al. 2002).

One important finding was the significantly lower consumption (and consequent lower mortality) by possums of unlured toxic bait compared to bait with cinnamon lure incorporated. This supports data from Morgan (1990), and reaffirms that cinnamon should always be used with cereal bait regardless of whether repellent is also applied or not.

7. Recommendation

- The AHB should proceed with formal field trials with cereal bait to confirm that the repellent significantly reduces the incidental by-kill of wild deer.

8. Acknowledgements

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9. References

Forsyth, D. M. 2002: Identifying a deer repellent for carrot possum baits. Landcare Research Contract Report LC0102/058 to Epro Ltd (unpublished) 13 p.

Henderson, R. J.; Frampton, C. M.; Morgan, D. R.; Hickling, G. J. 1999: The efficacy of baits containing 1080 for control of brushtail possums. *Journal of Wildlife Management 64:* 1138–1151.

Lorigan, R.; Yockney, I.; Nugent, G. 2002: Field trial: deer repellent carrot bait for possum control, Hampden, North Otago. Epro Ltd Contract Report to the Animal Health Board (unpublished) 14 p.

Morgan, D. R. 1990: Behavioural responses of brushtail possums, *Trichosurus vulpecula*, to baits used in pest control. *Australian Wildlife Research 17:* 601–613.

National Possum Control Agencies 2001. Trap-catch for monitoring possum populations. Wellington, National Pest Control Authority.

Nugent, G.; Yockney, I. 2002: Fallow deer deaths during aerial poisoning of possums in the Blue Mountains, Otago. Landcare Research Contract Report LC0102/044 to the Animal Health Board (unpublished) 26 p.

Nugent, G.; Fraser, K. W.; Asher, G. W.; Tustin, K. G. 2001: Advances in New Zealand mammalogy 1990–2000: Deer. *Journal of the Royal Society of New Zealand 31*: 263–298.

10. Appendix

Appendix 1 Site of Possum Field Trial, Te Wera Forest, Taranaki.