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Field Testing of a Deer-Repellent Carrot Bait for Possum Control – Tataraakina Replicate

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Project and Client

Landcare Research, Lincoln, and Epro, Taupo, conducted a trial for the Animal Health Board to assess the effectiveness of a potential deer repellent for reducing the incidental by-kill of deer during an aerial possum poisoning operation using carrot baits containing sodium monofluoroacetate (1080). The trial (AHB project R-80568-01) was conducted between June and September 2003.

Objective

- To confirm that addition of a deer repellent reduces to low levels the number of red deer killed incidentally during aerial 1080 carrot poisoning for possums.

Methods

- Three 2000-ha blocks were selected. One was aerially poisoned with 0.15% 1080-laden carrot, a second was treated with repellent-coated 0.15% 1080-laden carrot, and a third was not poisoned.
- Six expert hunters searched each block for 9 days before and 9 days after poisoning. The number of deer seen each day was recorded as an index of deer density. Incidental sightings of pigs, feral sheep and goats were also recorded.
- Before poisoning, deer-sized brown paper bags were placed at random locations throughout the block, to simulate deer carcasses. The percentage of these found during post-poison searches was used to estimate the percentage of deer carcasses found.
- Hunters also carried out 5-minute bird counts of three easily recognisable native bird species (kererū *Hemiphaga novaeseelandiae*, tomtit *Petroica macrocephala*, and robin *Petroica australis*) before and after poisoning.
- Possum kill was measured using standard NPCA protocol pre- and post-control RTCI monitoring. Sightings of live deer, deer carcasses, and paper bags by possum monitoring staff were also recorded.

Results

- Pre-poison sighting rates indicated that roughly five times as many deer were present in the repellent block as in the non-repellent block.
- The possum kill was high in both the repellent and non-repellent blocks (96.3% and 98.1% respectively).
- Deer sighting rates were lower in all three blocks after poisoning. The reductions were greatest in the two poisoned blocks, with no deer sighted in the non-repellent block during formal searches. However, the number of deer seen was too low and variable to determine statistically whether the declines differed between the two poisoned blocks, or between the unpoisoned block and the repellent block. The hunters subjectively considered that, on average, the amount of fresh sign they encountered had declined by about two-thirds in the non-repellent block, but had not changed in the other two blocks.
- Four deer (three fawns, one adult) and one blackbird were found dead in the non-repellent block, compared with no deer, three sheep, one pig and another blackbird in the repellent block. All of the deer found dead had eaten carrot bait, and their carcasses contained 1080 residues.

- The percentage of paper bags found indicated that 10–15% of the poisoned blocks were searched effectively for dead deer. The total number of deer killed in each block was estimated at 26 deer in the non-repellent block, and zero for the repellent block. However there is a 5% chance that up to 35 deer may have been killed in the repellent block without any carcasses being detected. That number of deaths would equate to a kill of less than 18%.
- There was no evidence of major changes in tomtit, robin, and kererū populations in both poisoned blocks, but the statistical power in these comparisons is likely to have been low.

Conclusions

- The deer repellent successfully reduced the by-kill of red deer in the repellent block, possibly to near zero. In contrast, there appeared to have been a greater than 50% kill in the non-repellent block.
- The possum kill was not measurably affected by addition of the deer repellent, and there were no indications of other major non-target effects with or without repellent.

Recommendations

- Where appropriate (in relation to high-level management goals and policies), the AHB should support operational use of the repellent on carrot bait where the risk of a large deer by-kill is a primary driver of opposition to the use of aerial 1080 poisoning as a possum control tool. Deer by-kill should be monitored the first few times the repellent is used operationally, to confirm its efficacy.
- AHB should proceed with formal field trials with 1080 cereal bait to confirm that the repellent substantially reduces the incidental by-kill of wild deer when cereal bait is used.

1. Introduction

Landcare Research, Lincoln, and Epro, Taupo, conducted a trial for the Animal Health Board to assess the effectiveness of a potential deer repellent for reducing the incidental by-kill of deer during an aerial possum poisoning operation using carrot baits containing sodium monofluoroacetate (1080). The trial (AHB project R-80568-01) was conducted between June and September 2003.

2. Background

The incidental killing of deer during aerial 1080 poison operations targeted at 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).

In an attempt to address the core concern of the pro-deer lobby, and of private landowners who see wild deer as a resource, Epro commissioned Landcare Research to develop a bait additive that would repel deer, but not possums. In 2001/02, a potential repellent was identified that substantially reduced consumption of carrot bait by farmed deer (Forsyth 2002), and we have subsequently shown that consumption of cereal bait was also reduced when the repellent was applied to the outside of the bait (Morriss et al. 2003). In separate field trials with 1080 carrot and cereal bait, the possum kill achieved with repellent-laden bait did not differ significantly from that achieved with ordinary non-repellent bait (Lorigan et al. 2002; Morriss et al. 2003). A field trial at Hampden, Otago, in 2002 attempted to assess the effectiveness of the repellent in protecting wild deer when used on carrot bait, and although the results were inconclusive, there was no evidence of deer being killed in the repellent block while 18 dead deer were found in a nearby area treated with non-repellent bait (Lorigan et al. 2002).

In this report, we document a second trial aimed at assessing whether the repellent reduced the percentage of deer killed during aerial 1080 poisoning of possums with carrot bait. The study was undertaken at Tataraakina, Northern Hawke's Bay, where a possum control programme has been instigated recently to prevent the spread of Tb northward through the Urewera Ranges. Several private landowners in the area derive significant income and/or other benefits from the wild deer population, and were unwilling to risk the loss of a major percentage of the deer population. This created an opportunity to test the repellent. We also assessed whether use of the repellent had a major effect on the possum kill and whether there was any evidence it increased the by-kill of common native bird species.

3. Objective

- To confirm that addition of a deer repellent reduces to low levels the number of red deer killed incidentally during aerial 1080 carrot poisoning for possums

4. Methods

4.1 Study design, approach, and areas

The basic approach was a Before-After-Control-Intervention (BACI; Underwood 1993) design, with normal 1080 carrot bait poisoning being the experimental control and repellent-coated 1080 carrot poisoning being the experimental treatment or intervention. We assessed deer density using the number of deer seen per day by expert hunters to index deer density, assuming that sighting rate was linearly related to density (as shown for fallow deer in the Blue Mountains by Nugent (1990)). We also used a mark-recapture approach to estimate the actual density of deer carcasses present after poisoning, using deer-sized brown paper bags as nominal carcasses to create an artificial marked sample. Changes in possum density were indexed using pre- and post-poison assessments of the standard Residual Trap Catch (NPCA 2001). We also attempted to detect major changes in the abundance of three common native bird species, using the 5-minute bird count method (adapted from Dawson & Bull 1975).

The pre- and post-poison assessments of the various indices were conducted in different seasons (because we could not wait a whole year before conducting the post-poison assessments, as that would have increased the likelihood of immigration, emigration, births and deaths affecting the indices). We therefore added a non-treatment (i.e. unpoisoned) block to the design, to check (and, if necessary, calibrate) for seasonal changes in the sightability of deer or in the detectability of the three bird species.

Three blocks of approximately 2000 ha each were chosen, with the blocks separated by about 3–6 km to minimise the chances of deer moving between the blocks. A block size of 2000 ha was chosen to be large enough to entirely encompass the home range of some tens if not hundreds of deer, but small enough to be able to search at least 10% of the area for carcasses.

The three treatments and blocks used (Appendix 1) were:

- Repellent 1080 carrot: ‘Wakeman’s’; the headwaters of the Mokomokonui River, owned by Simon Hall;
- Non-repellent 1080 carrot: ‘Matakuhia’; the headwaters of the Matakuhia Stream, public conservation land;
- Unpoisoned: ‘Tataraakina’; the headwaters of the Mangakara Stream, owned by the Tataraakina Trust.

Treatments were not allocated randomly to blocks, as permission to use 1080 poison on the Wakeman’s block was conditional on use of the repellent, and 1080 could not be used in the Tataraakina block.

4.2 Treatments

The aerial poisoning followed Epro's standard procedures for aerial 1080 carrot operations. Both repellent and non-repellent blocks were pre-fed once with non-toxic carrot (5 kg/ha) and then toxic carrot (5 kg/ha; nominally 0.15% 1080) was sown 8–9 days later. In the repellent block both the prefeed and toxic bait were surface-coated with repellent once 1080 and dye solution had been applied to the screened chopped carrot (average size 6 g).

In a previous trial (Hatepe trial; Speedy 2004), checks of the sown bait indicated that at least some of the repellent coating had been removed from bait by the sowing process. Measures were taken to reduce this potential problem.

Animal Control Products (ACP) using laboratory method LMJUNE 1997 (with a method detection limit of 0.5 mg/kg) determined the 1080 concentration of both repellent and non-repellent carrot bait.

4.3 Assessment of possum and non-target kill

Possum monitoring

The percentage of the possum population killed, and an index of the residual densities, were measured using standard NPCA-protocol pre- and post-control RTCI monitoring (NPCA 2001), at the recommended intensity for blocks of 2000 ha (i.e. 15 lines of 10 traps set for two or three fine nights). Possum monitoring was undertaken in the repellent and non-repellent blocks but not the unpoisoned block (because there was no reason to expect any changes in possum density). The work was undertaken by a combination of Landcare Research technical staff and independent NPCA-certified possum-monitoring contractors.

Deer percent kill

The three blocks were each 'hunted' (or searched) for 9 days before and 9 days after control by six expert hunters. The hunters were required to visit five predefined random points within a 2-km radius during each day. The random points visited before control were independent of those visited after. All encounters with deer, pigs, feral sheep and goats were recorded, and the location of each sighting determined using a Global Position System device (GPS). To minimise the effect of differences in hunter skill at locating deer, each hunter spent 3 days in each of the three blocks at each search time. Pre-control estimates were obtained 5 weeks before control (3–12 June 2003) and post-control estimates 2 weeks afterwards (12–21 August 2003).

The encounter data were used to generate deer-sighting rates for each block, which we used as an index of deer density. We generated confidence limits around these data to compare sighting rates between blocks, by modelling the number of deer seen each day (based on an assumed negative binomial distribution to account for deer being sighted in groups more often than would be expected by chance), using the Maximum Likelihood Method in a Bayesian framework (Hilborn & Mangel 1997).

Numbers of deer killed

To estimate the actual number of deer killed in each block, we created an artificial marked sample of 'carcasses' during pre-control hunts (by using numbered paper rubbish bags filled with leaf litter or fern as nominal deer carcasses) that could be used in a mark-recapture framework. Using the percentage of bags found as an empirical measure of the area of each

block effectively searched, we were able to extrapolate from the number of actual dead deer found to estimate the total number killed.

Bags were placed at each of the c. 90 random locations visited by hunters in each of the three blocks, and also wherever live deer were seen. Approximately 170 bags were also placed at regular intervals along randomly directed transects in the repellent and non-repellent blocks, respectively, to increase the sample size in these blocks. The GPS location of each bag was recorded, and a subjective assessment of the furthest distance from which each bag could be seen, averaged across the four compass points, was recorded.

During post-control hunts, hunters searched for bags and deer carcasses as well as live deer, with individual hunters directed to areas they had not visited before poisoning (i.e. most of the post-control hunting was in areas where the hunters had no prior knowledge of bag locations). The location and visibility of all bags and carcasses found were recorded. The possum-monitoring staff also recorded the locations and numbers of bags and carcasses found, and of any live animals seen. In an attempt to cover a greater amount of both poisoned blocks the possum monitoring staff involved were asked to traverse a different route to and from their trap lines each day, where time and weather permitted.

When dead deer were found, the lower jawbone was removed for ageing, and a sample of muscle (50 g) taken for 1080 analysis. The entire rumen was weighed and a sample of contents (1 litre) collected to determine presence and quantity of 1080 carrot bait in the rumen. The samples of rumen contents were later washed over a 2-mm sieve (in the laboratory), and the retained fragments searched for pieces of carrot bait. The wet weight of carrot found was expressed as a percentage of the total wet weight of the >2-mm fragments retained by the sieve, and then multiplied by the weight of rumen contents, as a crude estimate of the amount of bait in the rumen.

The percentage of paper bags found was used to estimate the detection probability for dead deer, with the total number of deer killed in each block then calculated by dividing the number of deer found by this detection probability. To estimate confidence limits about these estimates, we first calculated Bayesian ‘credibility intervals’ (Hilborn & Mangel 1997) and then calculated the probability of there being different numbers of dead deer in each block, given the actual number of dead deer observed, and given the uncertainty in the deer-detection probabilities. Put simply, we calculated the probability that the total number of dead deer in the non-repellent block was greater than the number in the repellent block.

Non-target impacts on birds

Four of the hunters with some initial familiarity with bird calls carried out 5-minute bird counts at each of the five random locations visited each day during hunting pre- and post-poisoning. As the hunters were not experienced bird counters, these counts focused on three well-known species (kererū *Hemiphaga novaeseelandiae*, tomtit *Petroica macrocephala*, and robin *Petroica australis*). The hunters were provided with taped birdcalls to improve their ability to identify the three species. This monitoring was secondary to the main aims of the research, and was intended only as an informal check for evidence of any major impacts of repellent bait on some common birds. Birds found dead during post-control monitoring were identified and had tissue analysed for 1080 residues.

4.4 Laboratory analyses

The 1080 concentration in deer and bird muscle was measured using Toxicology Laboratory Method TLM 005 (with a method detection limit of 0.002 mg/kg) at the Landcare Research Toxicology Laboratory.

5. Results

5.1 Treatments

Both treatment blocks were pre-fed on 16–17 July 2003, followed by toxic carrot (with and without repellent) on 25 July 2003. At least 3 nights of fine weather followed the sowing of the toxic bait. The concentration of 1080 in the standard carrot bait was 0.113%, compared with 0.121% in the repellent bait.

5.2 Possum kill and RTCI

Pre-poison Trap Catch Indices of 21 ± 9% and 16 ± 4% (95% CIs) for the repellent and non-repellent blocks, respectively, indicated both blocks contained moderate densities of possums (Table 1). The percentage kill and residual density achieved with repellent bait did not differ significantly from that for non-repellent bait (Table 1), with >95% kills and <1% RTCI being achieved with both bait types.

Table 1 Pre- and post-control RTCIs and percent kills in 2000-ha blocks at Tataraakina, Northern Hawke's Bay.

Block	Treatment	Pre (± 95%CI)	Post (± 95% CI)	% Kill
Wakeman's	Repellent	21 ± 9	0.8 ± 0.9	96.3
Matakuhia	Non-repellent	16 ± 4	0.2 ± 0.5	98.1

5.3 Deer kill

Percent kill

Analysis of the Bayesian posterior probability distributions for deer sightings during pre-control surveys combined indicates there is a 99.6% probability that the mean number of sightings in the repellent block were higher than in the non-repellent block. We therefore infer deer densities were much lower in the non-repellent block than in either the unpoisoned or repellent blocks, at least as measured by sighting rates during the 18 days formally designated as the sighting rate assessment period (Table 2). Some of this difference may reflect the slightly denser understorey in the no-repellent block, as the mean visibility of bags (i.e. the average distance from which each bag could be sighted, averaged across the four compass points) was 5.6 m in the repellent block, 4.6 m in the non-repellent block, and 5.9 m in the unpoisoned block. The hunters, however, considered that deer sightability in the two poisoned blocks was not hugely different, and the percentage of bags found in each during formal searches was similar (Table 2).

A further three and ten deer were seen by field staff in the non-repellent and repellent blocks, respectively, during 6 field days spent putting extra bags in each of these blocks. Adding these deer to those in Table 2, and assuming similar sightability of deer in the two blocks, the data suggest that deer densities in the repellent block were roughly five times higher than in the non-repellent block. The difference in density presumably reflects the lack of restrictions on both recreational and commercial hunting in the public conservation land that comprised (and surrounded) the non-repellent block.

Sighting rates were significantly lower in August, after the poison operation, with declines in all three blocks, but with greater declines in the two poisoned areas than in the unpoisoned area (Table 2). There is weak evidence that the ratio of deer seen before and after control differed statistically between the three blocks (contingency table, $X^2 = 7.9$, df = 2, $P = 0.08$). However, the numbers of deer seen each day were too low and too variable to statistically distinguish whether the 100% decline recorded in the non-repellent block differed significantly from the 56% decline in the repellent block. Neither can we distinguish whether the decline in the repellent block was greater than in the unpoisoned block.

Table 2 Number of animals seen or heard alive (with estimated 95% confidence intervals) or found dead during 18 days of hunting effort before and after the July 2003 poison operations, for each of three blocks. In addition the number of paper bags (simulated deer carcasses) distributed prior to poisoning, and the number and percentage of those found during 18 days of post-control hunting, are shown. The counts of live birds were recorded during specified 5-minute count periods during the days (not the whole day).

			Unpoisoned (Tataraakina)	**1080 + repellent (Wakeman's)**	**1080 no repellent (Matakuhia)**
No. of sacks deployed		Pre	107	268	263
No. of sacks found (%)		Post	10 (9.4%)	22 (8.2%)	28 (10.7%)
Deer	No. seen alive	Pre	43 (20–119)	27 (13–67)	4 (0–18)
	No. seen alive	Post	40 (27–63)	12 (7–29)	0 (0–4)
	No. found dead	Post	0	0	4
Pigs	No. seen alive	Pre	2	5	3
	No. seen alive	Post	3	2	0
	No. found dead	Post	0	1	0
Sheep	No. seen alive	Pre	0	54	0
	No. seen alive	Post	0	56	0
	No. found dead	Post	0	3	0
Goats	No. seen alive	Pre	3	0	0
	No. seen alive	Post	7	0	0
	No. found dead	Post	0	0	0
Blackbird	No. found dead	Post	0	1	1
Tomtit	No. heard alive	Pre	11	9	15
	No. heard alive	Post	8	17	6
Robin	No. heard alive	Pre	9	11	8
	No. heard alive	Post	2	6	11
Kererū	No. heard alive	Pre	2	3	6
	No. heard alive	Post	0	0	4

Despite the lack of deer sightings in the non-repellent block during the formal monitoring period after poisoning, some deer did survive in this block, as the possum-monitoring staff saw one deer near the edge of the block, and the hunters saw fresh sign on numerous occasions. Based on a subjective comparison of the amount of fresh sign seen before and after poisoning, these experts considered (on average) that the deer population had been reduced by about two-thirds. All of them considered that the amount of fresh sign had declined by more than half, whereas none considered that there had been any change in the amount of fresh sign seen in the repellent or the unpoisoned block.

Numbers of deer killed

Overall, about 10% of the paper bags were found during the 18 days of formal search effort in each block after the poison operation (Table 2). This indicates that about 10% (c. 200 ha) of each block was searched effectively for carcasses. In addition a further 12 bags were found during possum monitoring in the non-repellent block (increasing the total found to 15.2%) and seven in the repellent block (increasing the total found to 10.8%). Assuming the detection probability for carcasses was the same as that recorded for sacks, extrapolation from the four carcasses found in the non-repellent block suggests 26 deer were killed in this block, with a 95% Bayesian credibility interval of 10–69 deer. Likewise we estimate that no deer were killed in the repellent block with a 95% Bayesian credibility interval of 0–35 deer. Despite the substantial overlap in credibility intervals, analysis of the probability distributions indicates a 93% probability that the number of dead deer in the non-repellent block was greater than the number in the repellent block. This is strong evidence that the repellent protected deer as, if it had not, we would have expected to find many more carcasses in the repellent block, in line with the much higher pre-control sighting rate there.

The four deer found dead comprised three male fawns and one adult female (Table 3). If we assume that the ratio of adults to fawns in this population was the same as for deer populations generally (roughly three to one), the greater proportion of fawns in this sample approaches statistical significance (P = 0.051, binomial test, Sokal & Rohlf 1995). This provides weak evidence of higher mortality in young deer, and, conversely, provides another indication that at least some deer (older ones) survived.

All of the deer found dead had eaten carrot bait, but only small quantities were found in the rumen samples. Extrapolation from the percentage of carrot (wet weights) found in the subsamples of material sorted suggests these deer had consumed only 9–30 g of carrot bait (i.e. only 2–5 baits; Table 3), assuming that little of the bait had passed through the rumen by the time the deer died. All four deer also had concentrations of 0.7–1.2 mg/kg 1080 in muscle tissue indicating absorption and metabolism of a 1080 dose.

5.4 Other non-target kills

Numbers of pigs and sheep killed

The sighting rates for pigs were too low to be useful in calculating percent kill, but one dead pig was found (approximately 20 kg live weight) in the repellent block. For both poisoned blocks combined, an estimated total of 11 pigs were killed.

Three dead sheep (two lambs and a ewe) were found in the repellent block, simplistically suggesting that about 30 sheep were killed there. However, almost all the dead sheep were found on or near clearings, where their visibility would have been much higher than the

overall average visibility of bags within the fully forested areas (i.e. the number of carcasses would have been substantially lower than 30). Consistent with that, the number of sheep seen during the post-control hunt was almost identical to the number seen before poisoning (Table 2). Overall, the indications are that the percentage of sheep killed was low. As sheep were not the primary focus of the trial no samples were taken to test for presence of 1080.

Non-target impacts on birds

The numbers of birds counted during pre- and post- control hunts were low and variable (Table 2). Robins and tomtit numbers in both poisoned blocks combined were not affected by the poisoning (24 tomtits pre, 23 post, 19 robins pre, 17 post). The numbers of kererū counted were reduced after the poisoning (9 pre, 4 post), but the difference was not statistically significant. No native birds were found dead.

The one blackbird (*Turdus merula*) collected during post-control hunting contained 1080 residues (Table 3). Another blackbird was found dead by possum monitoring staff in the non-repellent block but was too decomposed for 1080 analysis.

Table 3 Amount of carrot estimated in rumens of four deer found dead, and concentration of 1080 in muscle samples from these deer and from one of the two blackbirds found dead.

Treatment	Species	Sex	Age (years : months)	Muscle residue (mg/kg)	Amount of carrot in rumen (g)
Non-repellent	Deer	Male	0 : 7	1.20	35.9
Non-repellent	Deer	Male	0 : 7	0.70	8.7
Non-repellent	Deer	Female	3 : 7	0.85	10.5
Non-repellent	Deer	Male	0 : 7	1.10	30.7
Repellent	Blackbird	Unknown	Adult	0.014	Not applicable

6. Conclusions

The possum kill was not measurably affected by addition of the deer repellent. However, these results show that more deer were killed in the non-repellent Matakuhia block than on the repellent-treated block, and suggest that the effect there was greatest on young deer. The declines in sighting rates appear to overstate the actual reduction in deer numbers. The 100% decline in the non-repellent block obviously is too high as fresh sign indicated deer were still present there (despite the absence of sightings). Likewise the 60% decline for the repellent block cannot reflect a 60% kill, as we estimate that this would have produced over 100 carcasses (see ‘population’ size calculations below), but we found none. Possible contributors to the sighting rate declines are (a) a small seasonal decline in sighting rate (sighting rate fell 17% in the non-treatment block); (b) greater disturbance by humans in the two poisoned blocks (as a result of pre-poison possum trapping and some extra hunting) compared to the unpoisoned block; and (c) the repellent may have caused some deer to move out of the block, as there is evidence from a farm trial that deer avoided the part of paddock in which repellent bait was placed. The hunters’ subjective assessments of the change in abundance of fresh

deer sign (tracks and droppings) between the pre- and post-poison surveys are consistent with the sparse data.

Some sheep were killed in the repellent block, but too few to affect sighting rates. As already noted, the estimated kill of 30 sheep is likely to be an overestimate, because sheep frequented the open country and any carcasses would have been much more easily seen than the majority of bags placed in forest country. However, some sheep were also killed in a pilot trial of repellent carrot bait at Hampden in 2002 (Lorigan et al. 2002), so this result hints that sheep may be somewhat less deterred from eating repellent-coated bait than are deer.

Some pigs were also killed, but the estimated total number killed in both poisoned blocks was low (11), and live pigs were seen afterward. Pigs have a rapid rate of increase and populations can recover quickly, especially if the pigs killed tended to be the smaller younger ones, as anecdotal evidence from other areas suggests.

There was no evidence of any kill or major effect on numbers of common native birds. The number of kererū seen after poisoning was lower, but it was zero in the unpoisoned block. However the bird-survey approach used and the low numbers of birds counted mean that we would have had low statistical power to detect anything other than a near-total kill of a bird species.

Since the completion (and as a result of the outcome) of this trial, Hawke's Bay Regional Council (HBRC) obtained approval to treat a further 4979 ha of the privately owned land north of the Wakeman's block that is managed for both conservation and hunting. The area was treated with repellent-coated 1080 carrot bait as part of a larger 11 756-ha block poisoned by Epro. Prefeed carrot was applied at a rate of 5 kg/ha during 8–13 September 2003, 3 weeks prior to toxic bait (0.08% 1080 carrot at 5 kg/ha) application (6–7 October 2003). The post-control possum RTCI was 1.1% for the whole c. 12 000 ha (A. Wilke, HBRC, pers. comm.). Although no formal monitoring of deer kill was done, the manager of the area and a team of track cutters sighted live deer and abundant fresh deer sign, but no dead deer, during 6 days spent in the poisoned area (P. Shaw, pers. comm.). Deer densities were considered to be similar to those in the Wakeman's block (P. Shaw, pers. comm.).

In summary, there is strong evidence that the repellent deterred deer, and reduced the deer by-kill probably to near-zero levels. The sparse data collected during this trial precludes precise estimation of a percent kill in both the repellent and non-repellent blocks, but we consider that collectively the subjective observations and limited quantitative data on numbers of killed animals and of a bias in the age structure of the deer killed provide grounds for believing the percent kill in the non-repellent block was high.

Accepting the hunters' subjective assessment of a two-thirds decline in the abundance in fresh sign as a reasonably accurate estimation of percent kill in the non-repellent block, that block will have contained about 40 deer before poisoning. The five times higher sighting rate in the repellent block indicates that about 200 deer are likely to have been present there, but at very worst fewer than 35 were killed (and most likely substantially fewer than that). If so, then the percent kill in the repellent block will have been below 18%. As annual productivity of hunted deer populations is usually more than 30% per annum (Nugent et al. 2001), the observed by-kill will have had little or no effect on long-term population levels.

7. Recommendations

- Where appropriate (in relation to high-level management goals and policies), the AHB should support operational use of the repellent on carrot bait where the risk of a large deer by-kill is a primary driver of opposition to the use of aerial 1080 poisoning as a possum control tool. Deer by-kill should be monitored the first few times the repellent is used operationally, to confirm its efficacy.
- AHB should proceed with formal field trials with 1080 cereal bait to confirm that the repellent substantially reduces the incidental by-kill of wild deer when cereal bait is used.

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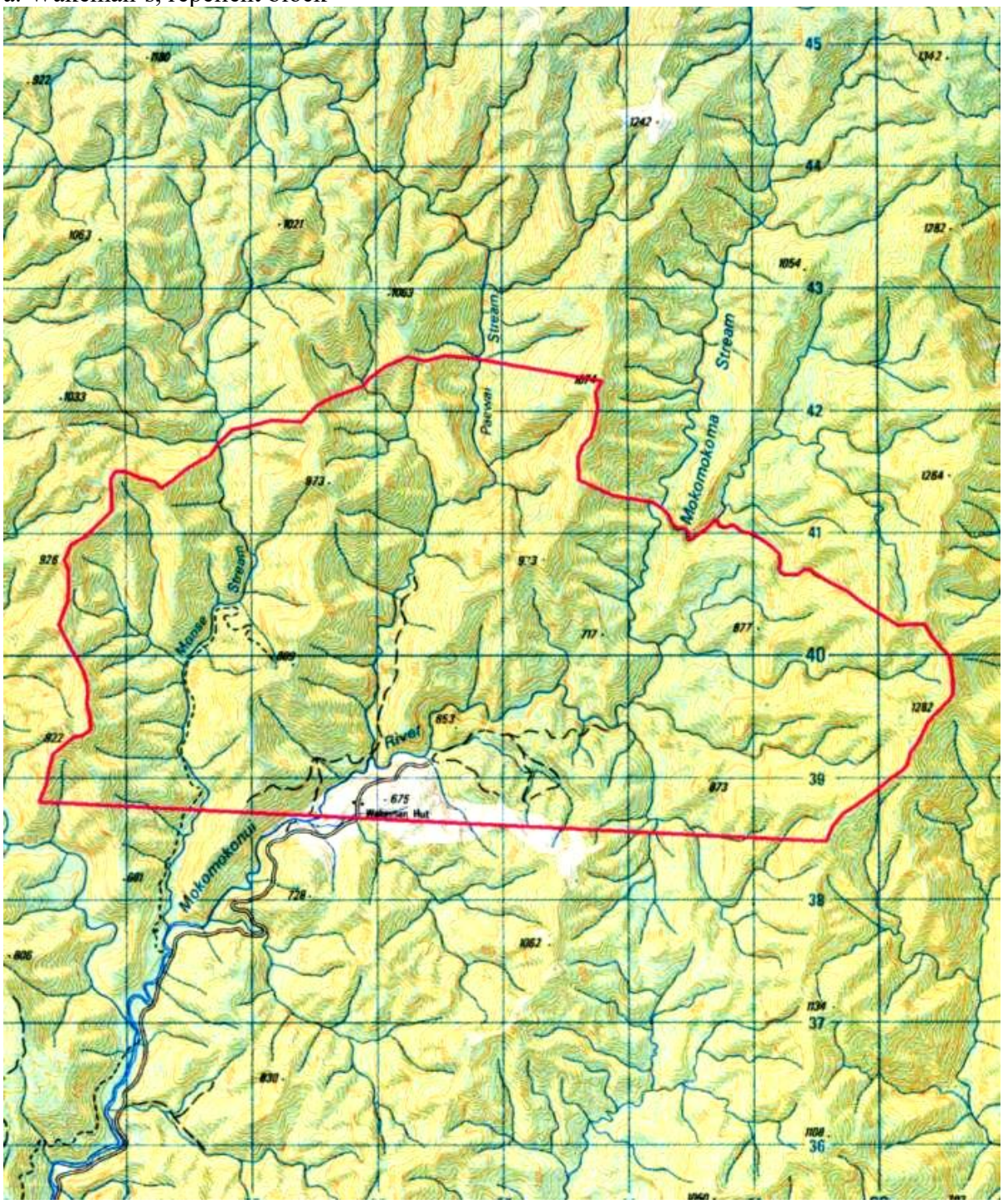
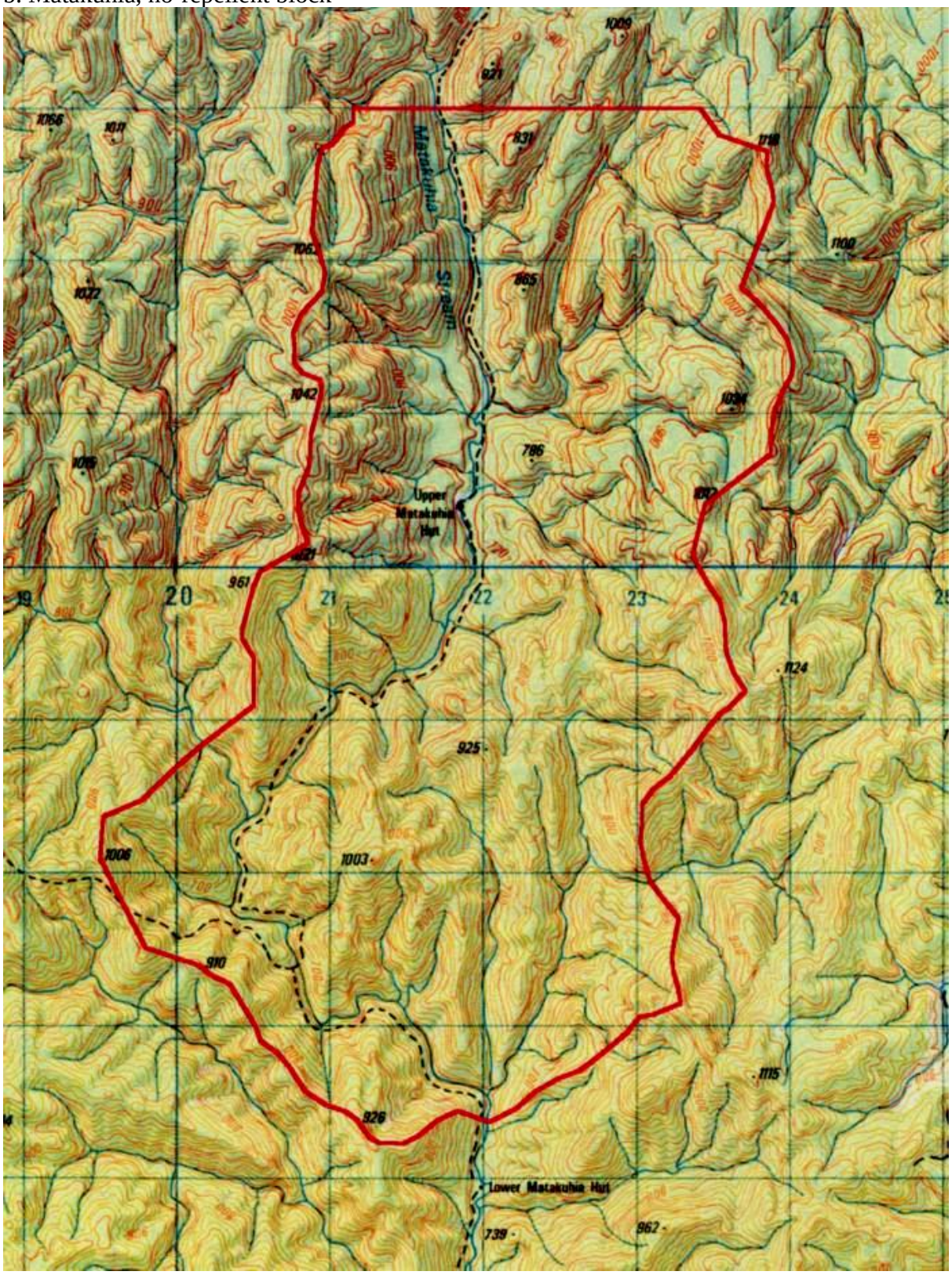
10. Appendix

Appendix 1 Maps of treatment blocks, Tataraakina, Northern Hawke's Bay

a. Wakeman's, repellent block



b. Matakuhia, no-repellent block



c. Tataraakina, unpoisoned block