2002 200

Field Trial: Deer Repellent Carrot Bait for Possum Control

Hampden, North Otago

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August 2002

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DOI: https://doi.org/10.7931/x7m7-0s17

Executive Summary

Project and Client

A pilot field trial of putative deer repellent carrot bait for possums was conducted by Epro Ltd, in collaboration with Landcare Research, Lincoln, as part of an aerial sodium monofluoroacetate (1080) poison drop in Hampden, North Otago, during June and July 2002.

Objectives

To determine whether a high proportion of red deer in Hampden, North Otago, are killed during a trial comparing 1080 carrot bait with and without a putative deer repellent, by:

- comparing efficacy against possums between the repellent and non-repellent areas
- assessing whether high proportions of the deer populations in the repellent and non-repellent areas had been killed
- estimating the number of deer killed in each area.

Methods

Aerially sown 1080 carrot bait was used to poison possums over 5,600 hectares of plantation forest owned by Blakely Pacific Forestry Ltd. Within this an 800 hectares area was treated with carrot bait that had a deer repellent added.

The effectiveness of the possum control was compared using the National Possum Control Agencies (NPCA) residual trap catch (RTC) protocol, using pre-control and post-control monitoring based on 10 lines of 10 traps. Further monitoring by Southern Pest Management was carried out for contractor performance over the total operational area.

The effect of the poisoning on deer densities in the repellent block, and in a nominally equivalent non-repellent block were to be assessed by comparing the encounter rates recorded by professional ground hunters before and after the poisoning, for both the repellent and non-repellent areas, but the apparent absence of deer from the non-repellent block during the pre-poisoning assessment meant there was no point in attempting to assess deer kill there.

The number of deer carcasses found during the post-poisoning survey was recorded, and the locateability of deer carcasses was assessed using simulated carcasses (brown sacks) placed in the field before poisoning. We also collected and collated information on post-poison sightings of live and dead deer by recreational hunters.

Results

The pre-poison RTCI of possum density for the repellent area was 14.6 percent. This is comparable with to 10 to12 percent Residual Trap Catch Index (RTCI) for the remainder of the operational area surveyed by Southern Pest Management (J. Bayley, pers. comm.).

Post-operational monitoring of the repellent block resulted in no possums being caught (0 percent RTCI). This result is comparable to a prior repellent trial carried out by Epro in Kaingaroa Forest where the pre-monitor RTCI was 26 percent and post-operational RTCI was 0.8 percent.

In the area where no repellent was used, the post-poison RTCI was 1.6 percent. With such low numbers these results are not significantly different from the repellent area to suggest that the repellent enhances the possum kill. However, it does show that the repellent does not have any detrimental effect compared to conventional carrot or pellet control.

No deer were encountered during six days hunting in the non-repellent block, so no further assessment was undertaken there. Encounter rates declined significantly (P=0.02) in the repellent block from 0.16 encounter per hour to 0.04 encounter per hour after control. Inclusion of a group of deer seen just outside the block reduced the pre-post difference, and made it not statistically significant (P=0.11). A recreational hunter familiar with the repellent block reported seeing a total of 18 live deer in or near the block during three days searching in the area. This included one mob of 11 deer.

Seven (42 percent) of 17 simulated carcasses were relocated by hunters unaware of their location. One deer carcass was found after poisoning, but the deer had been shot rather than poisoned. No other carcasses were found in the repellent block, but 18 carcasses were found by recreational hunters (15 confirmed by vector manager staff) elsewhere in the non-repellent area.

Conclusions

Carrot bait was highly effective in killing possums, with no evidence that inclusion of the repellent in any way diminished the efficacy of the bait in its intended role.

Deer encounter rates were lower after poisoning. This may reflect sampling error, a seasonal change in deer behaviour, or the death of some deer. At least one deer was shot, but there was no evidence other than the decline in encounter rates that any deer had been poisoned in the repellent block.

Assuming that relocation of simulated carcasses approximated the hunters ability to find carcasses, the 42 percent relocation rate indicates that we can be 60 percent confident there were fewer than two poisoned carcasses, and 95 percent certain there were six or fewer. The observation of a mob of 11 deer therefore suggests that at worst no more than 35 percent of the deer in the repellent area were poisoned.

Too few deer were present in the only trial areas available at Hampden to allow a robust test of the repellent's effectiveness in protecting deer, and even if the area had been more suitable the trial would still have been inconclusive (because of lack of replication). Nonetheless, the trial outcomes suggest that use of the repellent averted what appears to have been a high deer kill elsewhere in the poisoned area.

Recommendations

This trial should be replicated at least once more (on a larger scale in an area with higher deer numbers and with more intensive monitoring of deer densities), before deer repellent carrot bait can be recommended for initial operational scale use. Research and development aimed at finding better ways of adding the repellent to both carrot and to cereal bait should continue.

Comparison of deer encounter rates, and carcass counts should be considered as tools for assessing deer kill in any such trial (as an alternative to radio-collaring of deer or faecal pellet counts).

Background

The incidental killing of deer during aerial 1080 poisoning operations aimed at possums (*Trichosurus vulpecula*) creates considerable opposition by the hunting fraternity who oppose the use of aerially sown 1080 for possum control. This opposition also reflects on pest managers and the general public by raising the 1080 issue whenever a hunting resource is threatened. Incidental by-kill of deer from aerial 1080 poison range from an estimated zero to 93 percent deer kill (Nugent et al. 2001), and the recent poisoning of 66 to 75 percent of fallow deer *(Dama dama*) in the Blue Mountains RHA, Otago, highlighted the need to reduce the indirect costs of incidental deer deaths during aerial poisoning (Nugent and Yockney 2002).

One way to achieve this is to develop a repellent suitable for aerial application that repels deer but does not affect possum consumption. A candidate repellent has been identified by Landcare Research under contract to Epro. This repellent substantially reduced initial consumption of carrot bait by farmed red deer (*Cervus elaphus*) and had no significant effect on consumption or toxicity to possums (Forsyth 2002), but has not yet been field tested against wild deer. An opportunity to undertake a pilot trial testing the efficacy of the repellent in reducing deer by-kill was provided by an aerial 1080 poisoning operation planned for an area near Hampden, North Otago, in winter 2002.

The area to be poisoned comprised two main habitats, steep native forest in a Department of Conservation (DoC) reserve, and pine plantations owned by Blakely Pacific Forests Ltd, DoC usually requires that cereal, rather than carrot bait be used in DoC land, but the effectiveness of the repellent in reducing consumption of non-toxic cereal bait is not known. Likely time delays in gaining DoC approval to use carrot bait in DoC land, with or without repellent, meant that it was expedient to restrict the trial to the pine forest. In addition, the quantity of repellent available at the time limited the scale of the trial. Despite these limitations, the trial was proposed and supported by Southern Pest Management (the vector managers for the area), who, following the high kill of deer in the Blue Mountains in 2001, had made a commitment to Otago hunters to facilitate development of a deer repellent bait. Because of that commitment, the trial was undertaken at Hampden even though the scale and location of trial areas was less than ideal. Unfortunately, one of the trial areas selected was subsequently found to contain too few deer (possibly none) to provide any useful data, so the original objectives were not achievable. Despite that, some useful data were obtained. This report summarises trial outcomes.

Objectives

To determine whether a high proportion of red deer in Hampden, North Otago, are killed during a trial comparing 1080 carrot bait with and without a putative deer repellent, by:

- comparing efficacy against possums between the repellent and non-repellent areas
- assessing whether high proportions of the deer populations in the repellent and non-repellent areas had been killed
- estimating the number of deer killed each area.

Methods

Study Area

The Blakely Pacific forestry area available for the repellent trial was divided into two areas (northern and southern), and a trial block established in each area. The size of the trial blocks (740 hectares for the northern block, 720 hectares southern) was determined simply by the amount of repellent available at that time. The southern block was initially designated as the experimental treatment (to be poisoned with 1080 carrot bait with repellent included) and the northern block as the non-treatment site (1080 carrot bait without repellent). However, the pre-poison assessment of deer abundance in the northern block indicated too few deer (possibly none) were present there to provide useful data, so we could not measure the effect of the non-repellent treatment on deer as planned.

Using a global positioning system (GPS) guided helicopter, the treatment area was pre-fed with green-dyed non-toxic carrot containing the repellent at two kilograms per hectares on 13 June 2002, and then poisoned with toxic carrot (0.15 percent weight for weight (ww) 1080) containing the repellent at two kilograms per hectare 15 days later. The repellent was mixed and applied by an Epro staff member on site on both occasions; no difficulties were experienced in either bait application or delivery (K. Nicholas, Epro Ltd pers. comm.). The weather conditions after aerial application of the toxic bait was fine for three nights (J. Bayley pers. comm.). The non-treatment block, the remainder of the plantation areas, and DoC land were sown with similar but non-repellent bait at the same time. This was with either carrot at two kilograms per hectare pre-feed and two kilograms per hectare toxic or (on DoC land) pellet (12 grams) two kilograms per hectare pre-feed and two kilograms per hectare toxic (0.15 percent ww 1080).

Efficacy Against Possums

The possum kill was assessed in the two experimental blocks using pre and post-control RTCI monitoring (NPCA 2001). A total of 10 lines of 10 traps were randomly selected in each of the two trial areas. Post monitor lines were set approximately 200 metres from the pre-monitor lines. The traps used in the pre-monitor were soft catch with all possums caught being released. This approach enabled a comparison of post control possum densities on the two trial blocks plus comparative density on pre-control levels over the total operational area.

Performance monitoring for the total operational area by Southern Pest Management before and after the operation confirmed the pre-control densities and provided complementary data.

Impact on Deer

The proportion of deer killed in the treatment block was assessed by comparing hourly encounter rates recorded by four expert hunters before and after poisoning. The treatment and non-treatment areas were each divided into two roughly equal sized hunting blocks. To minimise variations in the encounter rate index caused by variation in hunter skill, each hunter hunted each sub area for one or two days about two to three weeks before poisoning, and on two days two to three weeks afterward, except that the planned post poisoning hunts of the non-treatment block were abandoned. All four hunters were very experienced ground hunters and three of them used trained deer indicating dogs. Each hunter was assigned a random start point for each day, and asked to hunt the block the way they would generally hunt. They recorded their location every hour (using a GPS), and qualitative assessments of deer sign (faecal pellets, tracking) and approximate age, as well as the number of dead birds, possums, and deer found during the post-poison hunts. Each hunter also provided their general impression of the impact of the poisoning on deer abundance in the repellent block. Percent kill was estimated by using a three-factor (treatment, observer, and block) analysis of variance in General Linear Model (SYSTAT 9.), 1999) to compare the hourly encounter rate before and after control.

The absolute number of deer killed in the repellent block was assessed using a mark recapture method involving simulated carcasses. During pre-poison hunts, hunters placed a uniquely numbered deer-sized red-brown sack filled with foliage or litter such as a simulated deer carcass, at the location where a deer or group of deer was seen, and also at nine random locations through the area. Hunters then recorded the location of all deer carcasses and sacks found during the post-poison hunts. The details of any dead, apparently poisoned, deer found were also to have been recorded, but no such deer were found. An upper confidence limit for the number of deer killed was calculated by determining the proportion of simulated carcasses found by hunters unaware of their location, and using that to estimate the probability of not finding any deer if in fact there had been either one, two, three, four or more deer killed in the area.

Incidental Observations

Although not planned as part of this trial, recreational hunters interested in the impact of the poisoning on their resource spent an unknown but considerable amount of time searching for deer carcasses in the parts of the poison area, and subjectively assessing deer kill. We endeavoured to collect relevant information from them.

Results

Applying the Repellent to Carrot Baits

The application of the repellent to the carrot bait was implemented by using a standard electric concrete mixer. Both the pre-feed and the toxic bait were treated using this method. The bait was first put into a 20 litre plastic bucket, which was then weighed. The weight of bait was 13 kilograms per 20 litre buckets. Two bucket loads (for example about 26 kilograms) of carrot were then put into the concrete mixer. The repellent was then added to the carrot and let to mix for approximately three to four minutes. This method is adequate for small quantities up to two to three tonne of bait, but would not be suitable for large quantities. Further testing is required to scale up the use of this repellent for large quantities of bait.

Efficacy Against Possums

The pre-poison RTC index of possum density for the repellent area was 14.6 percent. This is comparable with to 10 to12 percent RTCI for the remainder of the operational area surveyed by Southern Pest Management (J. Bayley, pers. comm.).

Post-operational monitoring of the repellent block resulted in no possums being caught (0 percent RTCI). This result is comparable to a prior repellent trial carried out by Epro in Kaingaroa Forest where the pre-monitor RTCI was 26 percent and post-operational RTCI was 0.8 percent.

In the area where no repellent was used, the post-poison RTCI was 1.6 percent. With such low numbers these results are not significantly different from the repellent area to suggest that the repellent enhances the possum kill. However, it does show that the repellent does not have any detrimental effect compared to conventional carrot or pellet control.

A 0.0 percent RTCI was recorded in the cereal pellet area.

Impact on Deer

As already noted, no deer were encountered in the northern non-treatment block during pre-poison hunts (Appendix One). The hunters saw no sign of deer presence, despite previous advice from locals that the area contained some deer.

For the treatment block, 13 deer were encountered (12 sighted) during 10 days hunting before poisoning, and five (three sightings) during 16 days hunting after poisoning (Appendix One). The mean hourly deer encounter rate declined from 0.16 encounter per hour during pre-poison hunts to 0.04 in the post-poison hunts, and the difference was statistically significant ($F = 7.72$, d.f. = 11, 10, $P = 0.02$). However, a group of three deer was seen by one hunter just outside the block, and inclusion of these deer reduces the size of the decline and renders it not statistically significant ($F = 3.17$, d.f. = 1, 10, $P=0.11$).

Scheduling difficulties arising in the reduction in the number of areas to be hunted meant that post control hunts were conducted in two parts, with one pair of observers hunting the area a week ahead of the other pair. The first pair considered the amounts of fresh sign seen was similar to that seen before poisoning, and therefore that there had been no major reduction in deer density. The second pair of hunters, hunting a week later, saw little very fresh sign, but did see sign they considered to be a week or so old, and suggested that the deer responsible may have moved out of the block as a result of disturbance from the first pair of hunters.

The locations and description of the deer seen during post control hunts indicates that at least seven survived the poisoning. One pig was also seen alive after the poisoning (compared to none before).

No apparently poisoned deer were found during post poison hunts, but one hunter killed deer, that is with the hindquarters removed) was found. It was assessed as having been killed after the pre-poison hunts. Seven (42 percent) of the 17 simulated deer carcasses were relocated by observers who had no prior knowledge of their location. Assuming from this that hunters had a 42 percent chance of finding any one dead deer, there is a two out of three chance the hunters would have found at least one deer if in fact two dead deer were present. Likewise, there is a greater than 95 percent chance they would have found one dead deer if six deer were present. The estimated number of deer killed is zero, with an upper 95 percent confidence limit of six.

Incidental Observations

At least two sheep were killed in the repellent block when a mob of sheep from an adjacent farm strayed into the repellent block about two weeks after poisoning.

Recreational hunters informally monitoring the nearby Wainakarua Scenic Reserve reported finding 18 dead deer within an approximate 147 hectare area west of the repellent block. Brent Rohloff (Field Officer, Southern Pest Management, and members of the North Otago New Zealand Deerstalkers Association (NZDA)) verified the location of 15 of these carcasses on 25 July 2002. Although the carcasses were considered too decomposed to collect jawbones or tissue samples, the 15 deer were subjectively classed as 10 mature hinds, two spikers, one yearling hind, one eight to nine month old stag and one eight to nine month old hind. The NZDA members classified the three deer not verified that day as two mature hinds and one mature stag. Eight of the 15 deer were found within a 47 hectare area that had been poisoned with cereal baits, with the remainder (seven deer found within 100 hectares) in the area poisoned with carrot bait (B Rohloff, pers.comm.).

As part of the informal monitoring by recreational hunters, one hunter familiar with the repellent block surveyed parts of that block 10 days after the poisoning. He found no dead deer, but reported seeing 11 live deer in a single mob within 300 metres of the block. They were on newly grassed farmland and the hunter was certain that they would have been using the repellent block for day-time cover. He sighted another mob of seven live deer, almost certainly many of the same deer, within the repellent block on another occasion. None of the randomly placed sacks were found by this hunter.

During the course of the post control hunts within the repellent area, the dead birds found by the hunters included two tomtits (*Petroica macrocephala*), two brown creepers (*Finschia novaeseelandiae*), two hedge sparrows (*Prunella modularis*) and three grey warblers (*Gerygone igata*). Five dead possums were also found.

Conclusions

Carrot bait was highly effective in killing possums with no evidence that inclusion of the repellent in any way diminished the efficacy of the bait in its intended role. This was compared to both the non-repellent carrot area and the cereal pellet area where RTC results were very similar in all three cases (ranges of 0.0 to 1.6 percent RTCI).

Our ability to quantitatively compare the effects on deer of the two bait types was confounded by the unforeseen scarcity of deer in the designated non-repellent block. Within the repellent block, we were able to assess deer encounter rates, and to detect a significant decline of about 75 percent in these rates within the block itself. That suggests that this methodology is at least potentially useful in this context.

However, the original aim was to compare encounter rates between treatment and non-treatment blocks, making the assumption that any changes in encounter rate not caused by changes in deer density would have been the same for both blocks. Without the non-treatment comparison, the decline in the repellent block is difficult to interpret – it may have been induced by the hunting itself, or reflect a seasonal change in deer behaviour or the death of some deer. One deer was shot in the area after the pre-poison hunt, and the continuous presence of two hunters with dogs in such a small area for two weeks appears likely to have had some effect. Inclusion of a group of deer encountered just outside the block renders the difference non significant. Taking the absence of carcasses into account (see below), we consider that the decline in encounter rate probably did not reflect a substantial decline in underlying deer densities, but more likely a behavioural changes that was in the main a consequence of the small size of the trial blocks relative to the typical home range sizes of red deer (100 to 500 hectares for adult females, twice that for males; Cluttonbrock and Albon 1989).

There was no evidence of any poisoned deer carcasses within the repellent block. If the relocation of simulated carcasses approximates hunters' ability to find carcasses, the 42 percent relocation rate indicates that we can be 66 percent confident there were two or fewer poisoned deer, and 95 percent certain there were six or fewer. The somewhat fortuitous observation of a mob of 11 deer in the area after poisoning therefore suggests strongly that at very worst no more than 35 percent of the deer using the repellent block were poisoned. Despite the unplanned nature of this observation, we see no reason to doubt its veracity, as the recreational hunters were, without doubt, seeking evidence of deer kill rather than deer survival. As what is effectively an upper 95 percent confidence limit of percent kill, this 35 percent kill is much lower than the two-thirds to three quarters kill of fallow deer in the Blue Mountains in 2001 (Nugent and Yockney 2001) and only one of the nine other estimates of percentage kill known for red deer is substantially lower than this (Nugent et al 2001).

The paucity of carcasses in the repellent block contrast starkly with the large number (18) found by recreational hunters in the nearby Wainakarua Scenic Reserve, both in carrot- and in cereal-baited areas, suggesting a significant kill in those areas. The search effort in this area concentrated on favoured winter areas for deer, which is likely to over-estimate the total number of deer killed if the density of dead deer were extrapolated over the entire poison area. However, in one of these high-deer-use areas, we know of at least 15 dead deer within a 147 hectare area, which equates to 10 deer per square kilometre.

Although the ages of the deer killed could not be verified, the number of nominally adult females (12) was far greater than the number of fawns (two). These contrasts with the predominance of fawns in the fallow deer killed in the Blue Mountains reported by Nugent and Yockney (2001), and calls into question their conclusion that large deer were at lower risk of poisoning than smaller younger deer. We see no obvious explanation of the difference.

The apparent poisoning of at least two stray sheep in the repellent block suggests that the repellent either did not repel sheep, or that the repellency was of comparatively short duration. The repellent may simply have washed off as occurred in previous pen trials with deer (Forsyth 2002).

Overall, too few deer were present in the small trial areas available at Hampden to allow a robust test of the repellent's effectiveness in reducing deer by-kill, and even if the area had been more suitable the trial would still not have been completely conclusive (because of lack of replication). Nonetheless, the trial outcomes suggest that what appears to have been a high deer kill elsewhere in the poisoned area did not occur in the repellent block, which provides circumstantial evidence that the repellent was effective.

Recommendations

This trial should be replicated at least once more (on a larger scale in an area with higher deer numbers and with more intensive monitoring of deer densities), before deer repellent carrot bait can be recommended for initial operational scale use. Research and development aimed at finding better ways of adding the repellent to both carrot and to cereal bait should continue.

Comparison of deer encounter rates, and carcass counts should be considered as tools for assessing deer kill in any such trial (as an alternative to radio-collaring of deer or faecal pellet counts).

Acknowledgements

Joe Bayley, Southern Pest Management for negotiating a suitable study site. Andrew Cocking Blakely Pacific Forestry for access and permission to trial this repellent within the forestry. Contractor hunters Dave Wilson, Rob Wilson, Robert Andrews and Kevin Mitchell for field work, observations and data collection. Brent Rohloff (Southern Pest Management) for independent validation of deer kill observations. Several recreational hunters provided useful information from privately conducted carcass searches.

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Appendix One

Pre-Poison Effort and Encounters

Block and Sub Area	Hunter	Deer Sighted	Deer Spooked	Effort (Hours)
Northern One	1	0	0	7.0
Northern One	2	0	0	8.0
Northern One	3	0	0	9.0
Northern Two	1	0	0	8.0
Northern Two	2	0	0	8.0
Northern Two	3	0	0	8.0

Block and Sub Area	Hunter	Deer Sighted	Deer Spooked	Effort (Hours)
Southern Three	1	0	0	9.0
Southern Three	2	0	0	7.0
Southern Three	3	1	0	9.0
Southern Three	4	3	0	15.0 *
Southern Four	1	4	0	9.5
Southern Four	2	12	0	9.0
Southern Four	3	2	0	9.0
Southern Four	4	1	1	11.5 *

* Two days hunting.

Post-Poison Effort and Encounters, with two days hunted by all four observers.

Area Plus Block	Hunter	Deer Sighted	Deer Spooked	Effort (Hours)
Southern Three	1	0 (plus 1 pig)	0	15.0
Southern Three	2	0	0	16.5
Southern Three	3	0	0	15.0
Southern Three	4	0	0	15.5
Southern Four	1	1	0	15.0
Southern Four	2	0	1	17.0
Southern Four	3	1	0	15.0
Southern Four	4	4 (plus 3 *)	1	17.0

* Three deer seen just outside block.