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Landcare Research

Operational-scale field testing of the efficacy of two deer-repellent 1080 possum bait types in Kaweka Forest Park

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Operational-scale field testing of the efficacy of two deer-repellent 1080 possum bait types in Kaweka Forest Park

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Summary

Project and client

- Manaaki Whenua – Landcare Research was commissioned by OSPRI to assess whether Prodeer®, a newly developed deer-repellent 1080 cereal bait for possum control, is effective for deterring sika deer (but not possums) from eating bait. An area baited with Epro Deer Repellent (EDR)-coated 1080 cereal bait (the currently used deer-repellent bait) was included to enable comparison between the two repellent types.
- Sika deer and possums were monitored using trail cameras during an aerial baiting operation undertaken to help eradicate bovine tuberculosis (TB) from possums. The work was undertaken between May 2022 and February 2023.

Objectives

The objective was to determine the possum control efficacy and incidental sika deer mortality incurred during aerial 1080 poisoning of possums using Prodeer and EDR deer-repellent cereal 1080 bait in Hawke's Bay.

Methods

- Two adjacent areas in Kaweka Forest Park, Hawke's Bay, were aerially poisoned with Prodeer (4,110 ha) and EDR deer-repellent 1080 cereal bait (3,342 ha) in September 2022. We used another adjacent unpoisoned area as an experimental control. Trail cameras were deployed in the operational and experimental control areas for 4 months before, and remained in place for 2.5 months after, the 1080 baiting.
- Animal visits to camera sites were characterised by date, time, species, and number of animals. The numbers of visits and visitors were used to compare changes in species' relative abundances before and after poisoning, taking into account the 'natural' (not related to 1080) changes in these indices in the unpoisoned area. Over 34,400 photos were analysed, comprising 5,133 visits and 5,483 visitors.

Results

- ***Prodeer: sika deer.*** The sika deer count per camera-week almost doubled in the Prodeer area post-control, which suggests an increase in deer activity compared to pre-control. The mean count was higher in the unpoisoned area compared to the poisoned Prodeer area in the pre period but declined in the post period. There was no effect of poisoning after accounting for the time+site effects, with an estimated increase in activity of 180% (95% CI = 86–342%) in the poisoned area.
- ***Prodeer: possums.*** The possum count per camera-week was unchanged in the unpoisoned area. The mean count was initially similar in the poisoned Prodeer area, but decreased substantially after poisoning, with an estimated decrease of 77% (95% CI = 65–84%).
- ***EDR: sika deer.*** The sika deer count per camera-week was unchanged in the poisoned area. There was no effect of poisoning after accounting for the time+site effects, with

an estimated increase in activity of 15%, (95% CI = –25%–75%) in the poisoned area. Seven dead sika deer were observed by locals in or near the EDR area. One of these was also encountered by field staff, sampled, analysed, and found to have low 1080 residue (0.0075 mg/kg).

- ***EDR: possums:*** The possum count per camera-week was unchanged in the unpoisoned area. The mean count was initially similar in the poisoned EDR area, but decreased substantially after poisoning, with an estimated decrease of 93% (95% CI = 87–96%).

Conclusions

- No sika deer by-kill was detected when Prodeer 1080 cereal bait was used in Kaweka Forest Park. The result is consistent with recent operations that monitored red deer by-kill (Molesworth Station in winter 2021 and Willowflat in spring 2022), when minimal red deer by-kill was detected following use of Prodeer 1080 cereal bait for possum control.
- Even if we assume that all dead deer observed in or near the EDR area had been killed by eating 1080 bait, there was no measurable effect on the relative abundance of the sika deer population detected by cameras.
- The control efficacy against possums using Prodeer 1080 cereal bait appeared moderate, with a 77% reduction in possum activity following poisoning. However, 60% of the possum visitors post-control in the Prodeer area were at one camera site, where possibly only one or two survivors were attracted to the camera, with 48% of these visits (23 of 48) being a possum interfering with the camera. Using more cameras per treatment area would reduce the influence of outlier sites.
- There was a 93% reduction in possum activity following poisoning with EDR 1080 cereal bait. This result is consistent with the Paemahi operation monitored in 2017, when EDR cereal bait was used and no surviving possums were detected.

Recommendations

- OSPRI should consider using either of these repellent 1080 baits where avoidance of a high risk of sika deer mortality is operationally important.
- When trail cameras are used for monitoring, we recommend 30 or more per treatment be deployed to minimise the influence of single sites within an area.

1 Introduction

Manaaki Whenua – Landcare Research was commissioned by OSPRI to assess whether Prodeer, a newly developed deer-repellent 1080 cereal bait for possum control, is effective for deterring sika deer (*Cervus nippon*) (but not possums; *Trichosurus vulpecula*) from eating bait. An area baited with Epro Deer Repellent (EDR)-coated 1080 cereal bait (the currently used deer-repellent bait) was included to enable comparison between the two repellent types. Sika deer and possums were monitored using trail cameras during an aerial baiting operation undertaken to help eradicate bovine tuberculosis (TB) from possums. The work was undertaken between May 2022 and February 2023.

2 Background

OSPRI relies heavily on aerial 1080 baiting for eradicating TB from possum populations in large areas of forest and mountain land in which possum control is difficult to achieve using ground-based methods (Warburton & Livingstone 2015). However, aerial 1080 baiting can sometimes result in a high level of incidental deer mortality and so is opposed by many hunters (Morriss et al. 2020). This opposition can sometimes limit OSPRI's ability to obtain landowner consent to use aerial 1080 baiting.

To reduce deer by-kill, three repellent bait formulations have been developed. EDR added to carrot and cereal bait as a surface coating has been widely used in the last two decades (Forsyth 2002; Nugent et al. 2004, 2012, 2017; Morriss et al. 2006; Morriss 2007). More recently, two other companies that manufacture bait, Orillion and Pest Control Research LP (PCR), have developed alternative formulations of deer-repellent cereal bait with the repellent incorporated into the bait.

OSPRI commissioned operational trials with both new products. In the first operational trial the PCR Pestex® deer-repellent 1080 cereal bait was tested in the Clarence Valley (Morriss et al. 2019). There was a 100% kill of radio-collared possums (n = 82). There was also a significant reduction (36%) in red deer (*Cervus elaphus*) by-kill (when compared with a no-repellent operation), but still a moderate to high by-kill of radio-collared red deer (19/30: 63.3% kill).

Subsequently, OSPRI commissioned another study to assess the alternative Orillion deer-repellent cereal bait (Prodeer®). A trial was carried out on Molesworth Station in winter 2021 (Morriss et al. 2021). There was a 100% kill of radio-collared possums (n = 161) and minimal by-kill of radio-collared red deer (2/39: 5.1%). Many live deer and few deer carcasses were observed post-poison.

In spring 2021, another operational trial assessed Prodeer when used in forested habitat (Morriss & Gormley 2022). This possum control operation at Willowflat Forest, Hawke's Bay, was monitored using trail cameras. There was a 96% reduction in possum activity post-poison, whereas red deer detections doubled. There was no evidence of any red deer by-kill, consistent with the low red deer by-kill measured during the previous Molesworth Station trial. A recommendation from this trial was that Prodeer should be assessed with other species of deer.

An OSPRI aerial 1080 possum control operation (Tūtaekurī Mohaka) along the eastern edge of the Kaweka Forest Park, Hawke's Bay, planned for late winter/spring 2022, was selected as the best available site at the time to assess the impact of using Prodeer bait on sika deer. Initial plans were to use Prodeer over the entire operational area, but following feedback from interest groups it was determined that the northern half of the treatment area, with high hunter use, would be baited with EDR-coated bait, which has been confirmed as having a lower risk of high sika deer by-kill compared with standard non-repellent operations (Morriss & Nugent 2017).

The remaining adjacent southern half (Gorge Stream) was then to be baited with Prodeer bait. This allowed direct comparison between the deer-repellent treatments, but increased the risk of edge effects (i.e. deer moving in and out of treatment areas, affecting measurements) by decreasing the size of the treatment areas. The inclusion of a comparison with a nearby unpoisoned area (experimental control) enabled us to adjust for seasonal changes in activity, which are independent of a poisoning effect.

This report documents the outcomes of an operational field test of the efficacy of Prodeer and EDR repellent baits in minimising sika deer by-kill under the standard treatments used by OSPRI.

3 Objective

The objective was to determine the possum control efficacy and incidental sika deer mortality incurred during aerial 1080 poisoning of possums using Prodeer and EDR deer-repellent cereal 1080 bait in Hawke's Bay.

4 Methods

4.1 Trial design and study area

4.1.1 Trial design

We used a before-after-control-impact (BACI) study design, with two experimental treatments (Prodeer and EDR deer-repellent 1080 aerial baiting) and an experimental control (an adjacent, unpoisoned area).

We assessed changes in the relative abundances of sika deer and possums by determining camera visit rates over 4 months before (pre) and 2.5 months after (post) the date on which 1080 baiting was conducted. Initial planning was for a minimum of 2 months of camera deployment before poisoning, but operational delays extended this to 4 months. Because the camera visit rate is influenced not only by changes in deer abundance but also by large seasonal changes in overall deer activity, as well as the potential for avoidance of camera sites as a result of humans visiting or even deer shying away from the cameras themselves, the design included monitoring deer visit rates in a non-treatment, experimental control (i.e. unpoisoned) area.

Previous deer by-kill monitoring trials have included systematic carcass searches (Morriss et al. 2006; Morriss & Nugent 2008; Nugent et al. 2012; Morriss & Nugent 2017), in which an estimate of search efficiency (and therefore deer carcass density) is derived by first deploying and then searching for a known number of deer-sized objects (paper sacks imitating deer carcasses). These searches were not included in the current trial design. Nevertheless, when cameras were deployed and retrieved, the numbers of live and dead deer seen were recorded. Dead animals observed during the camera service visit 3 weeks after poisoning were also recorded.

4.1.2 Study areas and treatment

The TB possum control operation (Tūtaekurī Mohaka) comprised 7,452 ha in Kaweka Forest Park, Hawke's Bay (Figure 1). The predominant habitat of the operational area is mānuka (*Leptospermum scoparium*) and kānuka (*Kunzea ericoides*), with patches of mountain beech (*Fuscospora cliffortioides*) and red beech (*Fuscospora fusca*). The south-eastern part of the Prodeer area consisted of production forestry (*Pinus radiata*). There are also large tracts of wilding pines (*P. contorta*), predominantly south of Kaweka Rd. The altitude in the area treated ranged from c. 600 m to c. 1,100 m asl.

The non-treatment, experimental control area was part of Kaweka Forest Park immediately west of the operational area. Habitat was similar to the treatment area. The cameras in the non-treatment area were at least 380 m from the operational area, with most (75%) greater than 1 km from the boundary (see Figure 1).

The area is popular with hunters and trampers, and there was unrestricted public access during the trial.

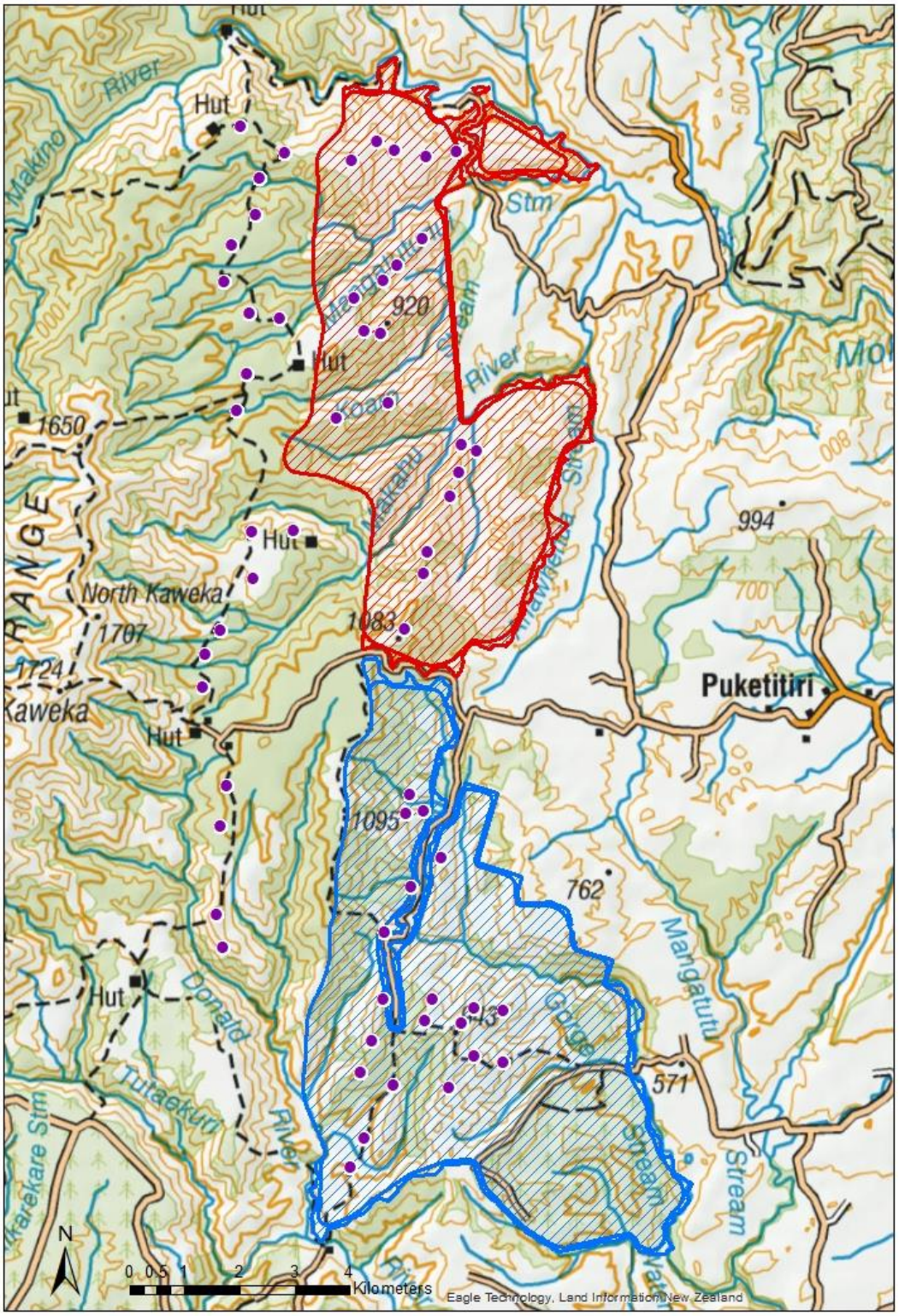

Figure 1. Tūtaekurī Mohaka TB possum control operational area in Kaweka Forest Park, Hawke's Bay, poisoned in September 2022. Prodeer 1080 bait was sown in the southern blue area and EDR 1080 bait in the northern red area. The location of trail cameras is depicted by the purple-and-white dots. The trail cameras to the west of the poisoned area are in the non-treatment area.

4.1.3 Baiting operation

The Tūtaekurī Mohaka baiting operation was carried out by Epro Ltd. Pre-feed was broadcast at 1 kg/ha on 2 September 2022 along flight paths 270 m apart. Prodeer and EDR 1080 bait (20 mm 12 g cereal baits) was broadcast at 2 kg/ha 16 days later on 18 September 2022 using the same flight path spacing. Precipitation (18.5 mm) was recorded on 19 September, with a total of 226.0 mm of precipitation recorded in the fortnight following toxic baiting, which would have rapidly detoxified the remaining uneaten bait.

4.2 Assessment of outcomes

4.2.1 Camera trapping

Over 17–19 May 2022, 60 trail cameras (Bushnell Aggressor) were deployed using a non-random design (i.e. high-animal-use sites where game trails were obvious were targeted). Walking tracks were used to access each of the areas monitored. Twenty cameras were arrayed in each of the two treatment areas and in the non-treatment area. Cameras were serviced (memory cards and batteries replaced) on 11 to 13 October 2022 to ensure they remained functioning for the duration of the trial. During this service visit one camera was missing, presumed stolen, and two had been interfered with and did not contain any photos. A new camera was installed where the stolen camera had been, and another camera was replaced because it had damaged mounting loops.

Cameras were secured to trees c. 1.5 m above the ground and pointed slightly downward but with at least 5 m visibility and left in place for c. 6.5 months. Most cameras (92%) remained functioning for the full period, but some stopped prematurely (two pre-poison and five post-poison). Conditions were wet during the trial, with 1,783.0 mm of rain recorded during the deployment period.

In total, 95,411 photos were recorded. Two thirds of these were not analysed because they were false triggers, which were predominantly caused by sunspots and wind moving vegetation (i.e. the camera sensor detected heat and movement and took a photo when there was no animal present). After accounting for these, we used 34,425 photos, of which 69% were of sika deer and 17% of possums (other species photographed are listed in Appendix 1).

4.3 Data analyses

The animal visits recorded by trail cameras were characterised by location, treatment, date, time, species, and number. The data were used to derive indices of animal activity that were assumed to reflect relative abundances. For each species, the numbers of visits and visitors were determined by classifying any image separated by more than 5 minutes from any other image of that species as a separate ‘visit’, and counting the number of different animals observed within each visit as the number of ‘visitors’. Note that multiple visits could be recorded by individual deer, and the same individual could also be photographed by different cameras.

The study period spanned 4 months before the poisoning date of 18 September 2022 and 2.5 months after. The metric, mean visitors per camera-week, was calculated for the entire pre- and post-toxin application periods separately. We also calculated mean visitors per camera-week for each 7-day period over the duration of the study in order to examine finer-scale temporal trends. All activity measures were calculated separately for the three areas (non-treatment, Prodeer, and EDR treatment).

The pre vs post data were analysed using a Bayesian generalised linear mixed model of the count of visitors per camera, with Poisson distributed errors and an offset term of the number of camera-weeks to account for the different length of monitoring before and after the 1080 operation. We included main effects of 'site' (unpoisoned vs Prodeer vs EDR) and 'time' (before vs after poisoning), the interaction between them (i.e. the effect of 'poisoning'), as well as a random effect of camera. This model specification allowed us to explicitly account for changes in animal activity before and after poisoning that were unrelated to the 1080 operation. The percentage change after accounting for time and site can be interpreted as an estimate of percentage kill in the case of a reduction.

The analysis was carried out using R (R Core Team 2021) with the analytical model specified in OpenBUGS 3.2.3 (Lunn et al. 2000). The model coefficients (intercept, time, site, poisoning) all had vague informative priors of normal (0, 10). We ran two MCMC chains each of 10,000 iterations after discarding a burn-in phase of 2,000 iterations. Convergence was assessed by R-hat values and visual inspection of the MCMC plots.

5 Results

5.1 Species recorded

In total there were 5,122 visits by 5,463 visitors over 6.5 months. The most common visitors were sika deer and possums (Table 1). Other species photographed included hares (*Lepus europaeus*), one hedgehog (*Erinaceus europaeus*), stoats (*Mustela erminea*), ship rats (*Rattus rattus*), a single cat (*Felis catus*), and birds (predominantly blackbirds (*Turdus merula*); see Appendix 1 for a summary of species). Note that the detection rates for smaller mammals and birds were probably biased low because cameras were set up to photograph larger species and were therefore sub-optimal for photographing smaller species.

Table 1. Number of sika deer and possum visitors recorded on trail cameras over 4 months before (pre) and 2.5 months after (post) poisoning with Prodeer and EDR 1080 cereal bait at Kaweka Forest Park, Hawke's Bay, September 2022, and a non-treatment site west of the poisoned area

	EDR		Prodeer		Non-treatment	
Visitor	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Sika deer	576	315	308	490	687	319
Possum	368	11	600	80	775	476

5.2 Changes in visitor rates for sika deer

Visits of sika deer were generally stable in all three areas pre-poisoning, albeit lower in the Prodeer area (Figure 2). After poisoning, the number of sika deer visitors remained largely unchanged, except for a marked increase in the Prodeer area in the final 3–4 weeks of the study.

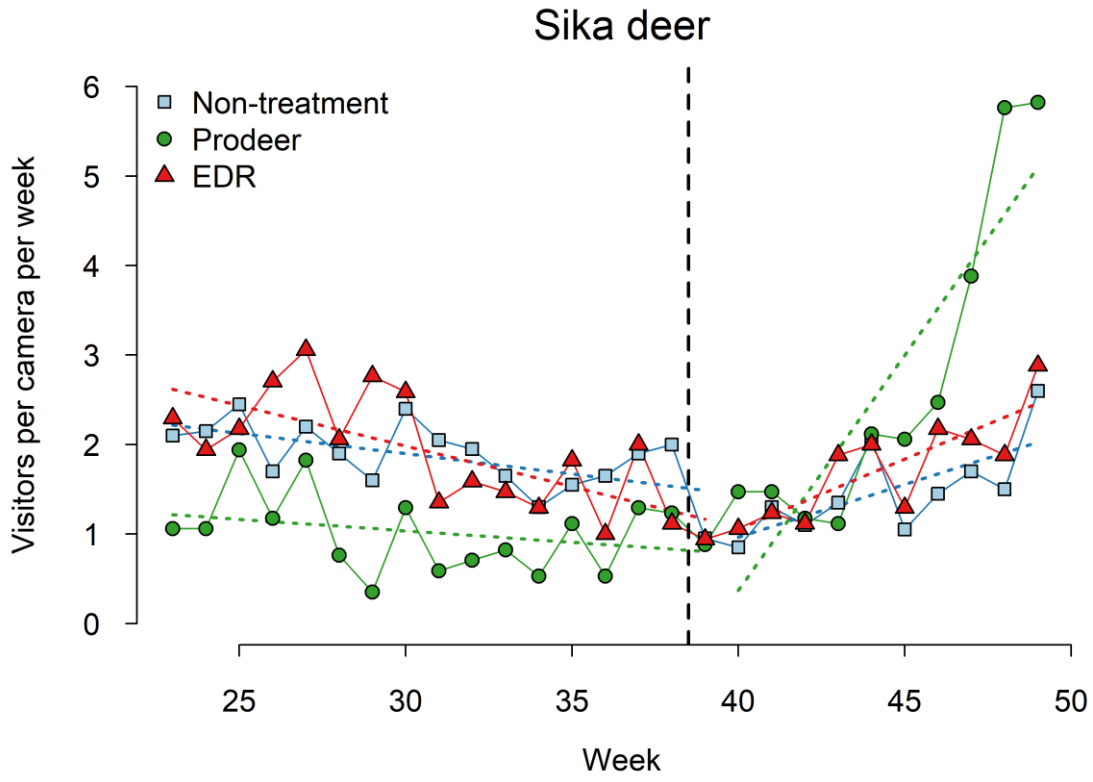

Figure 2. Mean sika deer visitors per camera for each 7-day period throughout the duration of the study. The black vertical dashed line indicates the timing of the poisoning with Prodeer and EDR 1080 cereal baits. The blue, green, and red dashed lines indicate the separate trend lines for the non-treatment, Prodeer, and EDR areas respectively, both pre- and post-control (from a simple linear regression with time as a covariate).

When grouped into the pre and post periods these patterns were more obvious, with visit rates decreasing in the non-treatment area, increasing in the Prodeer area, and remaining somewhat unchanged in the EDR area (Figure 3a). There was evidence of an overall decrease in sika deer detection from the pre to post period (Appendix 2), which can be attributed to environmental or seasonal changes. When accounting for this in the model, there was strong evidence of an increase of sika deer in the Prodeer area after aerial control (mean = 180%, 95% CI = 86–342%), but no evidence for any change in the EDR area (mean = 15%, 95% CI = –25%–75%) (Figure 3b).

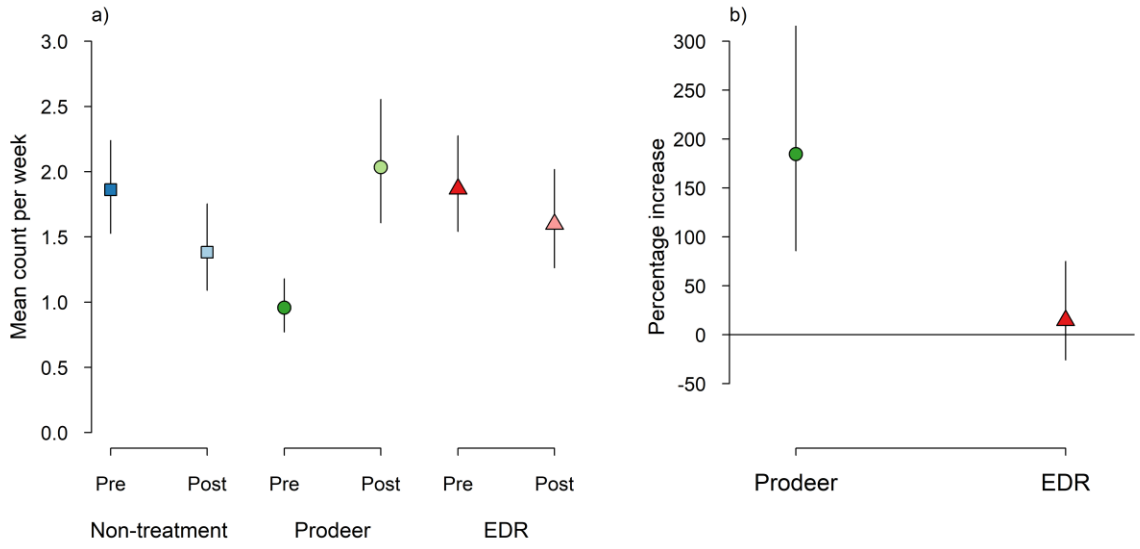

Figure 3. (a) The modelled mean count of visitors per camera-week (95% CI) for sika deer in the non-treatment, Prodeer, and EDR sites, both pre- and post-poisoning; and (b) the percentage change in deer activity after accounting for time and site.

5.3 Changes in visitor rates for possums

Visits of possums were stable throughout the pre-control period, albeit lower in the EDR area (Figure 4). Post-control, possum visitors decreased sharply and remained low in both the Prodeer and EDR areas (Figure 4). Possum rates showed an increase in the non-treatment area post-control.

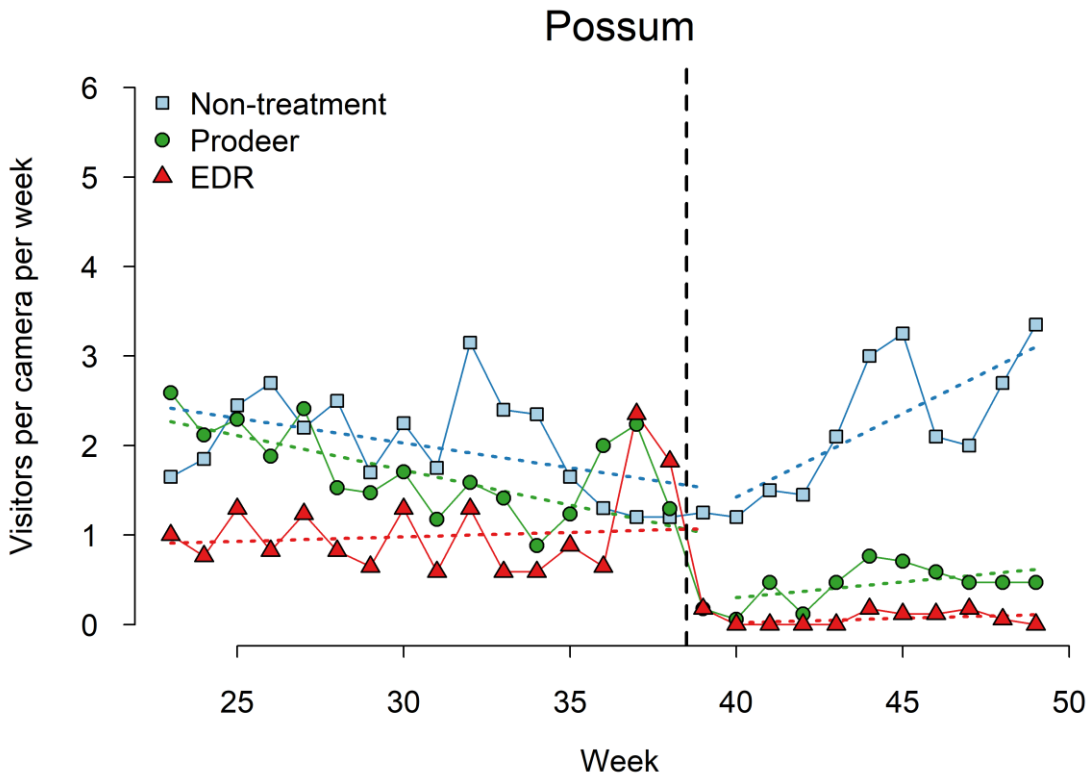

Figure 4. Mean count of possum visitors per camera for each 7-day period throughout the duration of the study. The black vertical dashed line indicates the timing of the poisoning with Prodeer and EDR 1080 cereal baits. The blue, green, and red dashed lines indicate the separate trend lines for the non-treatment, Prodeer, and EDR areas, respectively, both pre- and post-control (from a simple linear regression with time as a covariate).

When grouped into the pre and post periods, mean visit rates were unchanged in the non-treatment area, but decreased in both the Prodeer and EDR areas (Figure 5a). There was no evidence for an overall change in possum activity from the pre to post period due to seasonal factors (Appendix 2). When accounting for this in the model, there was strong evidence of a decrease in visit rates in both the Prodeer and EDR areas due to aerial poisoning (Figure 5a). Attributing the change in activity to changes in abundance, the estimate for percentage kill was 77% (95% CI = 65–84%) in the Prodeer area and 93% (95% CI = 87–96%) in the EDR area (Figure 5b).

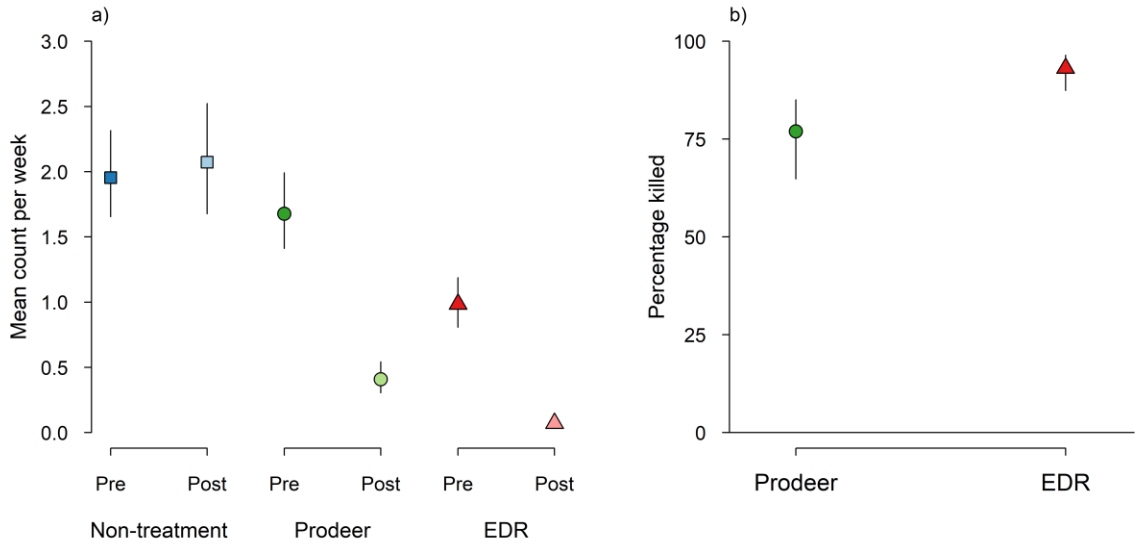

Figure 5. (a) The modelled mean count of visitors per camera-week (95% CI) for possums in the non-treatment, Prodeer, and EDR sites, both pre- and post-poisoning; and (b) the percentage change in possum visitors after accounting for time and site.

5.4 Incidental observations

Eighteen sika deer were seen or heard during initial camera deployment (Prodeer n = 10, EDR n = 4, non-treatment n = 4). The number of deer seen was influenced by the time of day, with sightings mainly occurring early in the morning or late in the day, when deer are more likely to be active.

Following poisoning, locals observed seven dead sika deer in and near the EDR treatment area (Chris Crosse, pers. comm., 10 October 2022). When staff serviced cameras (11–13 October 2022) one of these dead deer was encountered, so a muscle sample was collected, analysed at the Manaaki Whenua – Landcare Research Toxicology Laboratory using Laboratory Method TLM 005 (with a method detection limit of 0.001 mg/kg), and found to have low 1080 residue (0.0075 mg/kg). Ten dead possums were observed in the Prodeer area during camera servicing 3 weeks after poisoning.

During camera retrieval (1–4 December 2022) four live sika deer were seen (Prodeer n = 1, EDR n = 3).

6 Discussion

6.1 Efficacy of Prodeer and EDR baits in minimising deer by-kill

Our results showed that both Prodeer and EDR 1080 baits were effective for deterring sika deer from eating cereal 1080 baits. There was an overall decline in sika visitors pre vs post, which was independent of site and therefore due to environmental factors. Visitation rates in the EDR area were very similar to those in the non-treatment area, indicating little effect

of 1080 baiting even though some deer carcasses were observed. This was similar to the results observed at Paemahi in 2017, when 11 dead sika deer were found but it was concluded the by-kill was likely to be less than 10% (Morriss & Nugent 2017). Assuming visitation rates are an unbiased indication of population change, it can be concluded there was no change in sika deer numbers in this area.

Somewhat surprisingly, visitation rates of sika deer in the Prodeer area increased markedly after the poison operation, in contrast to the decrease in the non-treatment area. Much of the increase in the Prodeer area was in the last 3 weeks of the study, suggesting either a change in activity or an increase in numbers due to movement from adjacent areas. We observed increases in the red deer visitation rate at Willowflat as spring forage became available (Morriss & Gormley 2022) and suspect something similar happened in the Prodeer area that was not as obvious in the other two areas monitored.

6.2 Efficacy of possum control with Prodeer and EDR 1080 baits

The inclusion of deer repellent in cereal 1080 baits resulted in substantial reductions of possums in both the EDR and Prodeer areas. Assuming the change in visitation rates is an indication of population change, the estimated possum kill was very high (93%) in the EDR area, although was somewhat lower (77%) in the Prodeer area.

It is worth noting, however, that more than 60% of the observed possum visitors in the post-control period in the Prodeer area came from one camera, which was 280 m northwest of Lotkow Rd. The baiting flight line data indicate this camera site was well within the baited area, so it is unlikely that possums there were not exposed to bait. This could be an indication of high activity rates by one or two individuals that survived.

In support of this, it appears that these survivors were attracted to the camera, with 48% of the visits to this camera (23 of 48) being a possum interfering with the camera, whereas overall the rate was 13% (311 of 2,310). Removing this camera from the analysis resulted in an estimated percentage kill of 89%, which is more comparable to the EDR site and aerial 1080 applications in general. Ideally more cameras (i.e. 30 or more per treatment) should have been deployed, which would help to reduce the influence of single camera sites within an area.

Overall, the results of this field trial demonstrate that aerial poisoning with Prodeer 1080 bait substantially mitigates by-kill of sika deer while still achieving the level of possum kill required for eliminating TB.

7 Recommendations

- OSPRI should consider using either of these repellent 1080 baits where avoidance of a high risk of sika deer mortality is operationally important.
- When trail cameras are used for monitoring, we recommend 30 or more per treatment be deployed to minimise the influence of single camera sites within an area.

8 Acknowledgements

We thank Aran Proud, Luke Sutton, and contractor Kumi Basher (K B Training Limited) for assistance with camera deployment, servicing and retrieval. Also, thanks to the Department of Conservation Ahuriri/Napier Office for use of the Puketitiri Field Base during field trips. Thanks to OSPRI for funding, Dave Latham and Rachelle Binny for reviewing the report, Ray Prebble for editing, and Kate Boardman for final formatting of this report.

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Appendix 1 – Number and species of visitors recorded on trail cameras at Kaweka Forest Park, Hawke's Bay

Table A1. Number and species of visitors recorded on trail cameras over 4 months before (pre) and 2.5 months after (post) poisoning with Prodeer and EDR 1080 cereal bait at Kaweka Forest Park, Hawke's Bay, May to December 2022

	Prodeer		EDR		Non-treatment	
Visitor	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Sika deer	308	490	576	315	687	319
Possum	600	80	368	11	775	476
Rat	5		11		22	62
Hare	3	27		1	2	
Blackbird	11	8	65	21	13	5
Cat					1	
Stoat	2		2			2
Hedgehog		1				
Other bird	2	13	29	10	17	3

Appendix 2 – Model coefficients for sika deer and possums

Table A2. Model coefficients (Mean and SD) for sika deer and possums

		Sika deer		Possum	
Parameter	**Description**	**Mean**	**SD**	**Mean**	**SD**
β1	Intercept	0.620	0.097	0.670	0.086
β2	Prodeer site	-0.664	0.144	-0.152	0.123
β3	EDR site	0.007	0.138	-0.686	0.129
β4	Time	-0.296	0.155	0.057	0.134
β5	Prodeer effect	1.050	0.221	-1.470	0.216
β6	EDR effect	0.138	0.218	-2.686	0.326