Manaaki Whenua
Landcare Research

# Operational-scale field testing of the efficacy of deer-repellent Prodeer 1080 possum bait in Hawke's Bay

## OSPRI – OP-1004

Prepared for: OSPRI

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# Operational-scale field testing of the efficacy of deer-repellent Prodeer 1080 possum bait in Hawke's Bay

*Contract Report: LC4100*

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# Summary


### Project and client

- Manaaki Whenua – Landcare Research, Lincoln, was commissioned by OSPRI to assess whether Prodeer, a newly developed deer-repellent 1080 cereal bait for possum control, is effective for deterring red deer (but not possums) from eating bait.
- Deer, possums and pigs were monitored using trail cameras during an aerial baiting operation undertaken to help eradicate bovine tuberculosis (TB) from possums. The work was undertaken between June 2021 and April 2022.

### Objectives

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

### Methods

- A 5,395 ha area at Willowflat Forest, Hawke's Bay, was aerially poisoned with Prodeer deer-repellent cereal bait in October 2021. Trail cameras were deployed in the operational area for 4 months before and 2 months after the 1080 baiting, and also in a nearby unpoisoned area, the Maungataniwha Pine Forest.
- 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 188,500 photos were analysed, comprising 18,700 visits and 25,600 visitors.

### Results

- ***Deer.*** The count per camera-day almost doubled at both sites 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 both the pre- and post- periods. There was no effect of poisoning after accounting for the time+site effects, with an estimated increase in activity of 2% (95% CI = -5.5–10%) in the poisoned area.
- ***Possums.*** The count per camera-day was unchanged in the unpoisoned area. The mean count was initially much higher in the poisoned Prodeer area, but decreased substantially due after poisoning, with an estimated decrease of 95.6% (95% CI = 92.4–97.4%).
- ***Pigs.*** The count per camera-day decreased at both sites post-control, which suggests a general decrease in activity. The mean count was higher in the unpoisoned area than in the poisoned Prodeer area in both the pre and post periods. There was an apparent effect of poisoning after accounting for time+site, with an estimated activity decrease of 39% (95% CI = 47–54%). However, when grouped by week, pig activity

was already decreasing consistently in the Prodeer area before the poisoning operation, and there was no apparent change in this rate subsequent to poisoning.

**Conclusions**

- No red deer by-kill was detected when Prodeer 1080 cereal bait was used at Willowflat Forest. The baiting operation was carried out when spring growth was abundant, possibly reducing the likelihood of a high by-kill even if standard (non-deer-repellent) bait had been used, but the result is consistent with that measured at Molesworth Station in winter 2021, when minimal red deer by-kill was detected following use of Prodeer 1080 cereal bait for possum control.
- Prodeer 1080 cereal bait had high control efficacy against possums, with a 95.6% reduction in possum activity following poisoning.
- The 39% decrease in pig activity in the poisoned area may indicate some pigs were poisoned, but pig activity was trending down at both the Prodeer and non-treatment sites. Pigs were killed by hunters in both the Prodeer and unpoisoned areas at least prior to poisoning. If this harvest was higher in the Prodeer area, this could have contributed to the decrease in pig activity observed. The reduction is likely to be short-lived as pig hunting with dogs post-poison would have stopped due to the risk of dogs being poisoned, allowing pigs to breed with minimal disturbance.

**Recommendations**

- OSPRI should consider using Prodeer 1080 bait where avoidance of a high risk of deer mortality is operationally important.
- The seasonal and site-specific reliability with which Prodeer 1080 bait repels deer should also be assessed by monitoring deer mortality during 1080 operations in other areas (particularly where there are smaller-bodied deer species such as sika and fallow deer present), as suitable operations arise.

# 1 Introduction

Manaaki Whenua – Landcare Research, Lincoln, was commissioned by OSPRI to assess whether Prodeer, a newly developed deer-repellent 1080 cereal bait for possum control, is effective for deterring red deer (but not possums) from eating bait. Deer, possums and pigs were monitored using trail cameras during an aerial baiting operation undertaken to help eradicate bovine tuberculosis (TB) from possums. The work was undertaken between June 2021 and April 2022.

# 2 Background

OSPRI relies heavily on aerial 1080 baiting for the eradication of 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). That opposition can sometimes limit OSPRI's ability to obtain landowner consent to use aerial 1080 baiting. This dilemma has driven research and development aimed at finding methods that deter deer from eating 1080 baits.

Research starting in 2001 identified a repellent which, when added to carrot and cereal bait as a surface coating, changes the appearance and smell of the bait and successfully repels deer but is still palatable to possums and rats (Forsyth 2002; Nugent et al. 2004, 2012, 2017; Morriss et al. 2006; Morriss 2007). Epro Ltd have the proprietary rights to this product (Epro Deer Repellent: EDR), and it has been widely used in pest control operations throughout New Zealand. However, the surface coating of baits with repellent is an extra step in bait production and therefore substantially increases the cost of using baits coated with repellent.

Two other companies that manufacture bait, Orillion and Pest Control Research LP (PCR), have recently developed alternative formulations of deer-repellent cereal bait to be used for broad-scale possum and rat control. In both cases the repellent is incorporated into the bait during manufacture (whereas EDR is surface coated after bait manufacture). MWLR tested the palatability and efficacy of these new repellent formulations on both captive possums and ship rats, and both proved to be palatable and effective with both species (Morriss & Arrow 2018).

With no indication that either formulation affected possum control efficacy, OSPRI began to assess their effectiveness in repelling deer. 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 deer by-kill (when compared with a no-repellent operation), but still a moderate to high by-kill of radio-collared deer (19/30: 63.3% kill).

Subsequently OSPRI commissioned another study to assess whether the alternative Orillion deer-repellent cereal bait (Prodeer) might have higher efficacy in reducing deer by-kill. A trial was carried out on Molesworth Station in winter 2021 (Morriss et al. 2021). Prodeer deer-repellent cereal bait was sown over c. 69,000 ha, comprising three baiting treatments with differing sowing methods. There was a 100% kill of radio-collared possums (*n* = 161) and minimal by-kill of radio-collared deer (2/39: 5.1%). Many live deer and few deer carcasses were observed post-poison.

Concurrently with the Molesworth 2021 study, OSPRI commissioned the present study to assess deer and possum mortality when using Prodeer in forested habitat. This was originally initiated in the Tararua Ranges in mid-2020, but due to operational delays was abandoned in early 2021. A possum control operation at Willowflat Forest, Hawke's Bay, planned for late winter/spring 2021, was selected as an alternative site.

For operational reasons, OSPRI planned to use Prodeer bait over the whole area being baited. This precluded a direct treatment vs non-treatment comparison of outcomes within that area, based on concurrent use of a non-deer-repellent bait in at least part of it. This means that if deer survival was found to be high it would be difficult to tease apart whether it was because the deer repellent was highly effective, or because of some other factor, such as high availability of natural food. The inclusion of a comparison with a nearby unpoisoned area enabled us to adjust for seasonal changes in activity, which are independent of a poisoning effect.

This report documents the outcomes of a large-scale operational field test of the efficacy of Prodeer repellent bait in minimising deer by-kill under the standard treatment used by OSPRI.

# 3 Objective

The objective was to determine the possum control efficacy and incidental red deer and pig mortality incurred during aerial 1080 poisoning of possums using Prodeer 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 one treatment (Prodeer deer-repellent 1080 aerial baiting).

We assessed changes in the relative abundances of red deer, possums and pigs by determining camera visit rates over 4 months before and 2 months after 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 (i.e. unpoisoned) area. Permission was gained to use the adjacent Maungataniwha Forest owned by Simon Hall as a non-treatment site (site description below).

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 of 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 were not included in the current trial design due to budget limitations and forestry operations within the operational area. Nevertheless, when cameras were deployed and retrieved, the numbers of live and dead deer seen were recorded.

### 4.1.2 Study areas and treatment

The TB possum control operation comprised 5,395 ha at Willowflat Forest, Hawke's Bay (Figure 1). The habitat consisted mostly of production forestry (*Pinus radiata*), with compartments ranging from newly planted to mature trees, some of which were being felled at the time of the baiting operation. The compartments being felled were excluded from the operation (see Figure 1). The altitude in the area treated ranged from c. 200 m to c. 600 m asl.

The non-treatment area, Maungataniwha Pine Forest, is managed by the Forest Lifeforce Restoration Trust with the aim of restoring threatened species of fauna and flora. It was formerly production forestry but was clear-felled during 2006-18. Part of the area has been replanted with mānuka (*Leptospermum scoparium*), but large areas consist of regenerating pine habitat, some of which had been treated with herbicide in preparation for mānuka planting. There was at least a 3.75 km buffer between the Prodeer and non-treatment areas at Willowflat Forest (see Figure 1).

Both the Prodeer and non-treatment areas have restricted access with limited hunting of both deer and pigs so both areas have moderate to high densities of these animals. Both areas also have histories of possum control, with the treatment area last aerially poisoned in October 2017 and the non-treatment area in October 2018. Ground control of possums was being carried out in some parts of the non-treatment area during the period of this study.

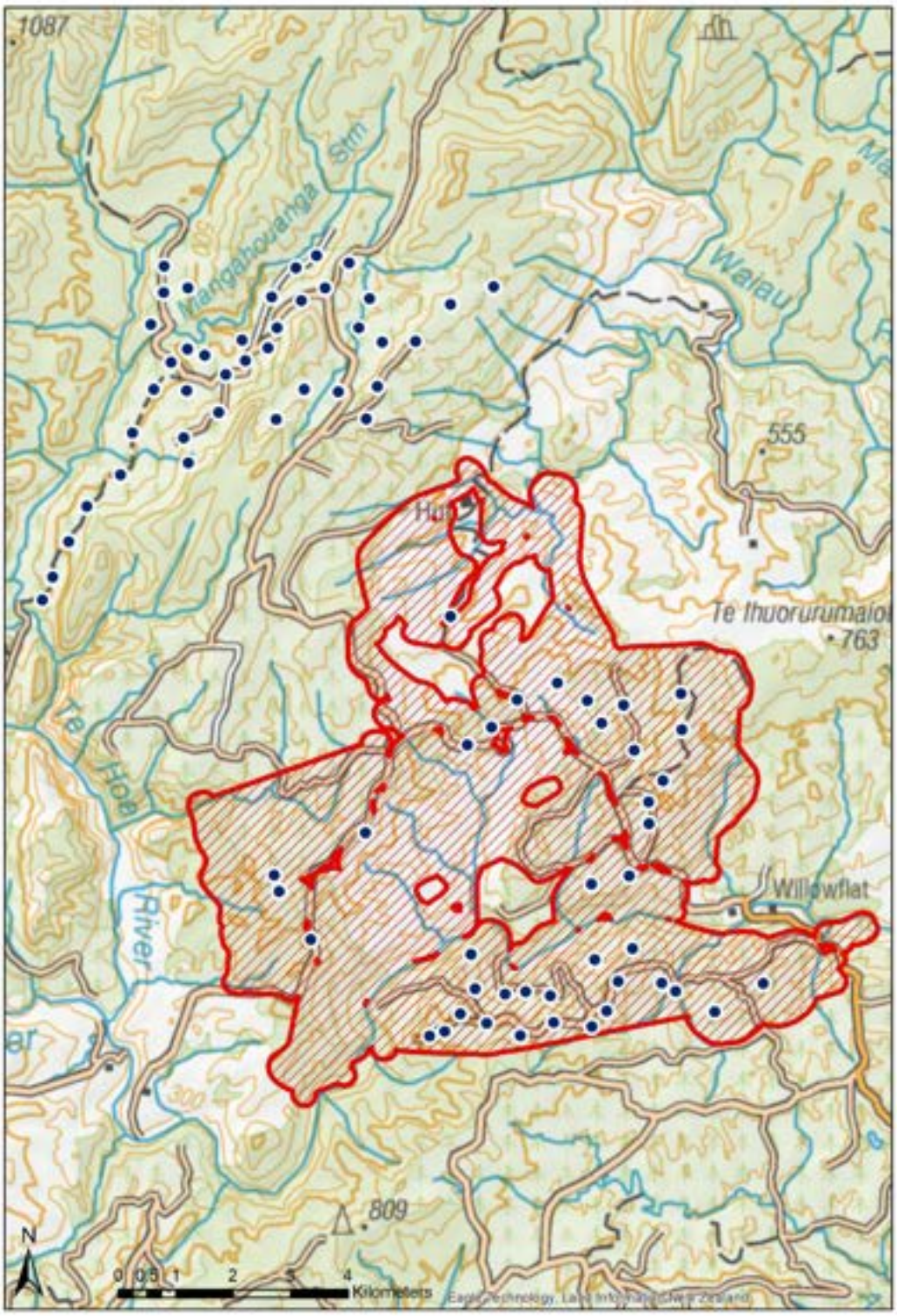


**Figure 1. TB possum control operational area at Willowflat Forest, Hawke's Bay, poisoned in October 2021. The cross-hatched area shows where bait was sown, with exclusions (open polygons) around current felling operations, a public road (exclusion partially shown) and private land (lower middle). The location of trail cameras is depicted by the blue-and-white dots. The trail cameras to the northwest of Willowflat Forest are in the non-treatment area, Maungataniwha Pine Forest.**

### 4.1.3 Baiting operations

The Willowflat Forest baiting operation was carried out by Epro Ltd. Pre-feed was broadcast at 1.5 kg/ha on 2 October 2021 along flight paths 270 m apart. Prodeer 1080 bait (20 mm 12 g cereal baits) was broadcast at 2 kg/ha 13 days later on 15 October 2021 using the same flight path spacing. Trace precipitation (0.5 mm) was recorded on both 16 and 17 October, then 8.5 mm was recorded on 18 October 2021. A total of 215.0 mm of precipitation was recorded in the month following toxic baiting.

## 4.2 Assessment of outcomes

### 4.2.1 Camera trapping

Over 18–22 June 2021, 80 trail cameras (70 Bushnell Aggressor, nine Reconyx XR6, and one Bushnell Trophy Cam) were deployed using a non-random design; i.e. high-animal-use sites were targeted, either in clearings or along road or forest edges where game trails were obvious. Forest roads allowed easy access for deploying cameras and coverage of the large area monitored. Forty cameras were arrayed in each of the treatment and non-treatment areas. Cameras were serviced (memory cards and batteries replaced) on 15 to 16 October 2021 to ensure they remained functioning for the duration of the trial. During this service visit, three cameras were repositioned when they were found to be on trees that had blown over or were obstructed by other trees that had. One Bushnell Aggressor camera was replaced with a Bushnell Core DS camera when the former was found to be damaged.

Cameras were secured to trees at 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 months. Most cameras (88%) remained functioning for the full period, but some stopped prematurely (seven pre-poison and 12 post-poison).

In total, 386,585 photos were recorded. Half of these were not analysed because they were false triggers, which were predominantly caused by wind moving vegetation (i.e. the camera sensor detected movement and took a photo when there was no animal present). After accounting for these, we used 188,498 photos, of which 68% were of deer, 14% of pigs, and 1% 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 15 October 2021 and 2 months after. The metric, mean visitors per camera-day, was calculated for the entire pre- and post-toxin application periods separately. We also calculated mean visitors per camera-day for each 7-day period over the duration of the study in order to examine finer-scale trends. All activity measures were calculated separately for the Prodeer treatment and non-treatment areas.

The before vs after 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-days to account for the different length of monitoring before and after the 1080 operation. We included main effects of 'site' (unpoisoned vs Prodeer) and 'time' (before vs after), 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).

# 5 Results

## 5.1 Species recorded

In total, there were 18,704 visits by 25,567 visitors over 6 months (Table 1). The most common visitors were deer, pigs, goats and possums (Table 1). Other species photographed included hares, rabbits, cats, hedgehogs, stoats, rats and birds (predominantly pheasants, magpies and blackbirds; see Appendix 1 for a summary of species). 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. Although red deer were by far the most common species photographed, fallow deer were also recorded, albeit far less frequently (33 visits by 47 visitors), mostly in the non-treatment area, but also post-poisoning in the Prodeer area.

**Table 1. Number of images of the four most common species recorded on trail cameras over 4 months before (pre) and 2 months after (post) poisoning with Prodeer 1080 cereal bait at Willowflat Forest, Hawke's Bay, October 2021, and a non-treatment site in the nearby Maungataniwha Pine Forest**

| | Prodeer | | Non-treatment | |
|---|---|---|---|---|
| **Visitor** | **Pre-** | **Post-** | **Pre-** | **Post-** |
| Deer* | 1,755 | 1,799 | 5,507 | 5,622 |
| Pig | 1,234 | 293 | 2,747 | 1,288 |
| Goat | 1,078 | 1,304 | 91 | 50 |
| Possum | 893 | 23 | 82 | 54 |

* Predominantly red deer, but also includes a small number of fallow deer (1% of deer visitors).

## 5.2 Changes in visit rates

For deer, visit rates increased over the monitoring period at both sites, which most likely reflects increased activity as fresh spring grass growth became available and there were more visits to feeding areas in front of the cameras (Figure 2 & Table 2). The weekly trend in pig activity decreased slightly in both the non-treatment and treatment sites (Figure 2), with activity at the Prodeer site in the post-control period half that in the pre-control period (Table 2). Possum activity remained unchanged in the non-treatment site as well as in the Prodeer site prior to control (Figure 2 & Table 2).

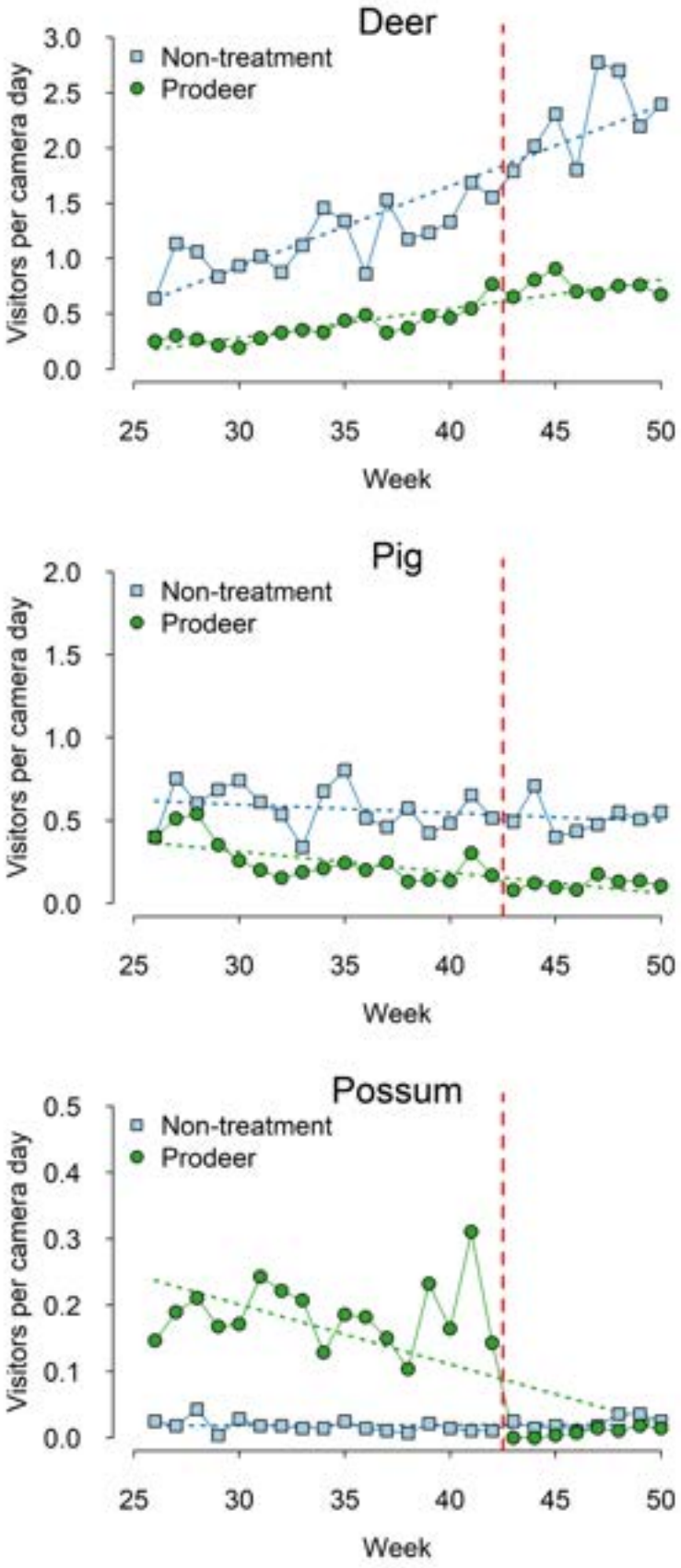


**Figure 2. The mean visitors per camera-day for each 7-day period throughout the duration of the study. The red vertical dashed line indicates the timing of the poisoning with Prodeer 1080 cereal bait. The blue and green dashed lines indicate the overall trend lines for the non-treatment and Prodeer sites, respectively**

**Table 2. Change in the number of visitors per camera-day recorded on trail cameras over 4 months before (pre) and 2 months after (post) poisoning with Prodeer 1080 cereal bait at Willowflat Forest, Hawke's Bay, October 2021, at both the Prodeer and non-treatment sites**

| | Prodeer | | Non-treatment | |
|---|---|---|---|---|
| | **Pre** | **Post** | **Pre** | **Post** |
| **Mean camera-days** | | | | |
| | 110 | 58 | 108 | 57 |
| **Visitors per camera-day** | | | | |
| Deer* | 0.40 | 0.77 | 1.24 | 2.43 |
| Pig | 0.27 | 0.12 | 0.63 | 0.55 |
| Possum | 0.19 | 0.01 | 0.02 | 0.02 |

* Predominantly red deer, but also includes a small number of fallow deer (1% of deer visitors).

### 5.2.1 Change in deer visit rate

Deer activity continually increased throughout the duration of the study (Figure 2), with the visitors per camera-day almost doubling at both sites (pre- to post-control); the magnitude of this increase suggests an overall increase in deer activity. The mean visitors per camera-day was higher in the non-treatment block than in the Prodeer block in both the pre- and post-poisoning periods (Figures 2 & 3). There was no effect of poisoning after accounting for the time+site effects, with an estimated change of 2% (95% Credible Interval [CI] = -5.5–10%) in the poisoned area.

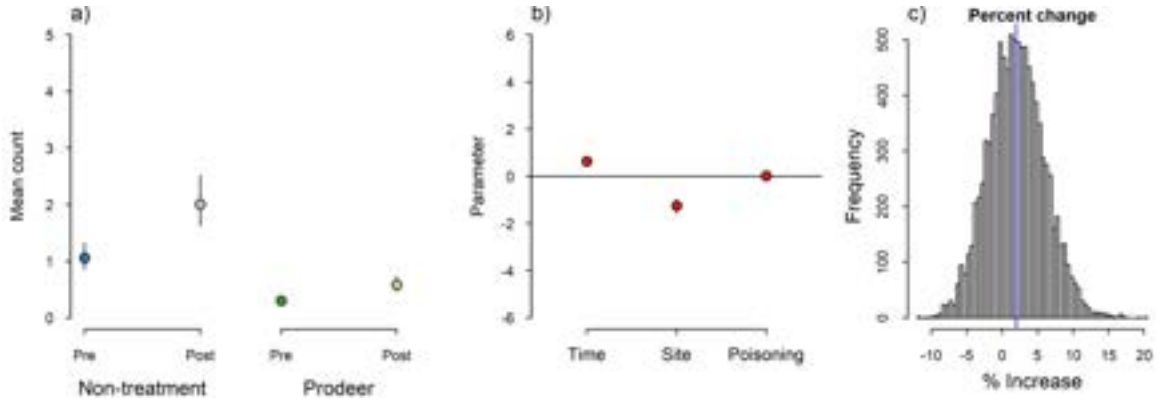


**Figure 3. (a) The mean count of visitors per camera-day (95% CI) for deer in the non-treatment and Prodeer sites, both pre- and post-poisoning; (b) model parameter coefficients for effect of time, site and poisoning; and (c) the percentage change in deer activity after accounting for time and site.**

### 5.2.2 Change in pig visit rate

Pig activity gradually decreased throughout the duration of the study (Figures 2 & 4). The mean number of visitors per camera-day was higher in the non-treatment block than in the Prodeer block, in both the pre- and post-poisoning periods (Table 3). There was an apparent effect of poisoning after accounting for time+site, with an estimated activity decrease of 47% (95% CI = 39–54%). It is possible this decrease may be partially attributable to 1080 poisoning, but pig activity (as measured by the mean weekly visitors per camera-day) was decreasing at the Prodeer site prior to control (Figure 2).

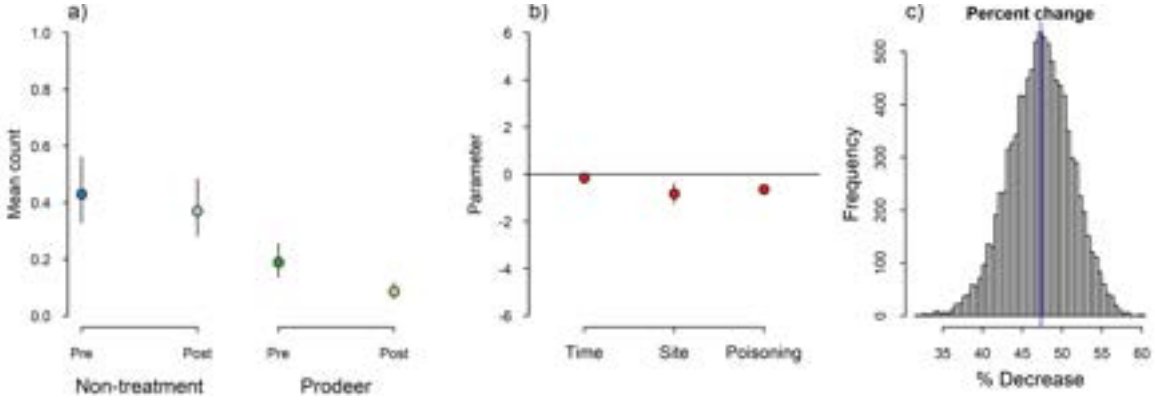


**Figure 4. (a) The mean count of visitors per camera-day (95% CI) for pigs in the non-treatment and Prodeer sites, both pre- and post-poisoning; (b) model parameter coefficients for effect of time, site and poisoning; and (c) the percentage change in pig activity after accounting for time and site.**

### 5.2.3 Change in possum visit rate

Possum activity was relatively constant before the control operation and remained unchanged at the non-treatment site (Figure 2). The mean number of visitors per camera-day was initially much higher in the Prodeer block, but decreased sharply immediately after poisoning (Figure 2), with an estimated decrease of 95.6% (95% CI = 92.4–97.4%; Figure 5c).

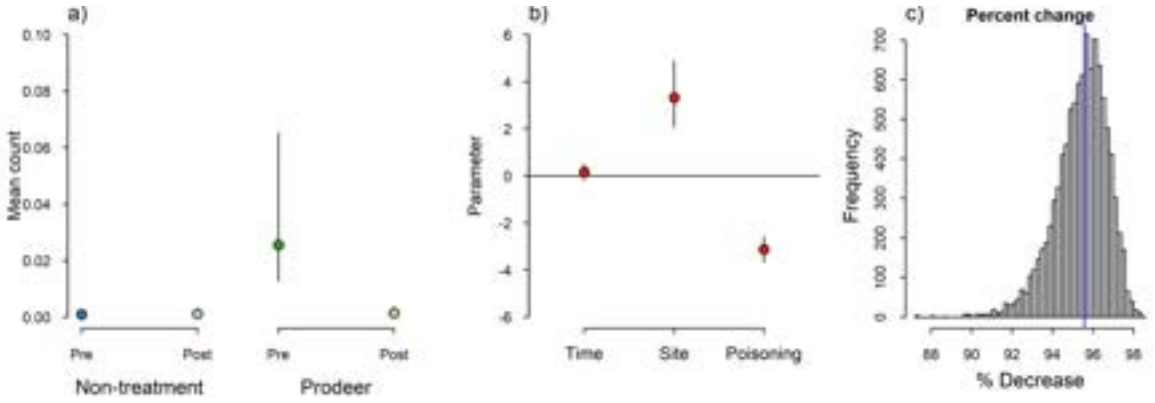


**Figure 5. (a) The mean count of visitors per camera-day (95% CI) for possums in the non-treatment and Prodeer sites, both pre- and post-poisoning; (b) model parameter coefficients for effect of time, site and poisoning; and (c) the percentage change in possum activity after accounting for time and site.**

## 5.3 Incidental observations

### 5.3.1 Deer sightings

Deer were seen in both areas during camera deployment and servicing, and when the cameras were removed (Table 3). 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 they were more likely to be active.

**Table 3. Deer observed during camera deployment, servicing, and camera removal at Willowflat Forest (Prodeer treatment) and Maungataniwha Pine Forest (non-treatment), Hawkes Bay, October 2021**

| | Prodeer | | Non-treatment | |
|---|---|---|---|---|
| **Visit** | **Pre** | **Post** | **Pre** | **Post** |
| Deployment | 9 | | 33 | |
| Service | | 5 | | 10 |
| Removal | | 7 | | 31 |

# 6 Discussion

## 6.1 Efficacy of Prodeer bait in minimising deer by-kill

Our results show that Prodeer 1080 bait was highly effective for deterring red deer from eating 1080 cereal baits. Deer were photographed at all camera sites in the operational area post-poisoning and the visit rate was higher than that recorded prior to poisoning, with deer activity continuing to increase (Figure 2). The increase in deer activity at Willowflat Forest was similar to that observed at the non-treatment Maungataniwha Pine Forest site. No dead deer were found incidentally during camera servicing and removal, although no systematic carcass searches were included in this study. The result is consistent with that achieved when Prodeer bait was used at Molesworth Station in winter 2021 (Morriss et al. 2021), giving confidence that the bait minimises deer by-kill, at least in the habitat types and seasons that have so far been assessed.

The baiting at Willowflat Forest was carried out in October, when spring grass was growing, creating an abundant food source for deer. This natural food source may have reduced the likelihood of deer eating bait even if standard non-deer-repellent bait had been used. However, part of Molesworth Station was poisoned with standard 1080 bait at the same time of year in 2017, with the same fresh spring grass growth, and a high by-kill of deer (89%) was observed (Morriss et al. 2018), indicating deer could find standard 1080 bait more palatable than fresh grass growth, with resultant mortality.

A small number of fallow deer were photographed in the poisoned area, but only after baiting had occurred. It is likely that they were exposed to the bait, but lower activity rates

and low numbers prior to poisoning meant they were not recorded. Nevertheless, it is an indication that this species may also be deterred from eating 1080 cereal baits if Prodeer is used.

### 6.2 Impact of Prodeer bait on pigs

There was a substantial decrease in pig activity (47%) following poisoning, after adjusting for time and site effects. It is unlikely, however, that this reduction was due to by-kill from the 1080 bait. When looking at the weekly data, pig activity was decreasing consistently at the Prodeer site before the poisoning operation, and there was no apparent change in this rate afterwards (Figure 2). Furthermore, no pig carcasses were observed when cameras were collected 2 months after baiting, despite dead pigs having been observed previously when standard and EDR deer-repellent 1080 baits have been used for possum control (e.g. Nugent et al. 2017: 26 dead pigs were found in post-poisoning searches).

Although not conclusive, the reduction observed here is within the bounds of what could be expected if by-kill had occurred. Regardless of the cause of the decrease, pigs in New Zealand have the potential to double their population within a year in suitable conditions (McIlroy & Nugent 2021). If there had been by-kill it is therefore expected that the population would recover quickly, especially as there would have been little hunting with dogs because of the risk of them being poisoned for the months following toxic baiting.

### 6.3 Efficacy of possum control with Prodeer 1080 bait

The inclusion of deer repellent on cereal 1080 bait appeared to have no adverse effect on the possum control operation. Using pre-fed Prodeer 1080 bait resulted in a high control efficacy against possums, with an estimated kill of 95.6%. The control operation was immediately effective, with possum activity dropping sharply at the Prodeer site; possum activity in the 2 weeks immediately after the control operation was zero, and then remained very low in the subsequent 6 weeks until the end of our study (Figure 2). Possum distribution was also substantially reduced, with possums photographed by 5 of the 40 cameras post-poisoning at Willowflat Forest, compared with 29 cameras prior to poisoning.

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

## 7 Recommendations

- OSPRI should consider using Prodeer 1080 bait where avoidance of a high risk of deer mortality is operationally important.
- The seasonal and site-specific reliability with which Prodeer 1080 bait repels deer should also be assessed by monitoring deer mortality during 1080 operations in other areas (particularly where there are smaller-bodied deer species such as sika and fallow deer present), as suitable operations arise.

## 8 Acknowledgements

We thank Aran Proud and Morgan Coleman for assistance with camera deployment, servicing and retrieval. Thanks to Simon Hall, owner of the Maungataniwha Forest and chairman of the Forest Lifeforce Restoration Trust; Pete Shaw, Simon's land manager; and Barry Crene, caretaker/manager at Waiau Camp, who allowed access and assisted with the project. Also, thanks to Dave Byrne and Lawrence Weston, district foresters with Rayonier Matariki Forests, who permitted access to the operational area. Thanks to OSPRI for funding, Dave Latham and Simon Howard 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 Willowflat Forest, Hawke's Bay

**Table A1. Number and species of visitors recorded on trail cameras over 4 months before (pre) and 2 months after (post) poisoning with Prodeer 1080 cereal bait at Willowflat Forest (Prodeer) and Maungataniwha Pine Forest (Non-treatment), Hawke's Bay, June to December 2021**

| | Prodeer | | Non-treatment | |
|---|---|---|---|---|
| **Visitor** | **Pre** | **Post** | **Pre** | **Post** |
| Deer | 1,755 | 1,799 | 5,507 | 5,622 |
| Pig | 1,234 | 293 | 2,747 | 1,288 |
| Goat | 1,078 | 1,304 | 91 | 50 |
| Possum | 893 | 23 | 82 | 54 |
| Hare | 193 | 99 | 63 | 7 |
| Rabbit | 119 | 7 | 350 | 113 |
| Cat | 86 | 19 | 20 | 9 |
| Hedgehog | 8 | | | |
| Rat | 2 | | | 1 |
| Stoat | | | 4 | 3 |
| Pheasant | 48 | 33 | 14 | 14 |
| Thrush | 20 | | 2 | 4 |
| Tomtit | | | 3 | |
| Magpie | 21 | | 33 | 3 |
| Quail | 29 | | | |
| Blackbird | 85 | 2 | 1 | 7 |
| Other bird | 37 | 3 | | |

**Table A2. Model coefficients (mean and 95% credible intervals in parentheses) from the GLMM for each species and the percentage change after controlling for site and time effects**

| Effect | Deer | Pig | Possum |
|---|---|---|---|
| Time | 0.64 (0.60, 0.68) | -0.15 (-0.22, -0.08) | 0.17 (-0.19, 0.50) |
| Site | -1.25 (-1.57, -0.97) | -0.83 (-1.24, -0.39) | 3.32 (2.08, 4.89) |
| Poisoning | 0.02 (-0.06, 0.10) | -0.64 (-0.79, -0.50) | -3.12 ( -3.67, -2.59) |
| % Change | 2.0% (-5.5%, 10%) | -47% (-54%, -39%) | -95.6% (-92.4%, -97.4%) |