Impact of aerial 1080 baiting with deer-repellent and standard bait on white-tailed deer on Rakiura / Stewart Island

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s9(2)(g)(ii)

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Summary

Project and client

The Bioeconomy Science Institute (BSI) was commissioned by Zero Invasive Predators Ltd to assess the non-target impact of aerial 1080 baiting on white-tailed deer (*Odocoileus virginianus*) on Rakiura / Stewart Island. The work was undertaken between March and December 2025.

Objective

To determine and compare the non-target impacts on white-tailed deer of (i) standard Pronature™ Dry Forest 1080 cereal bait and (ii) Prodeer® Possum + Rat deer-repellent 1080 cereal bait when used for pest control on Rakiura / Stewart Island.

Methods

- Two adjacent areas on Rakiura / Stewart Island were aerially treated with toxic bait; one with deer-repellent 1080 bait (8,441 ha) and one with standard 1080 bait (32,089 ha) in August 2025. We also used an adjacent untreated area as an experimental control. Movement-activated cameras were deployed in the three areas for 3 to 6 weeks before, and remained in place for 7 to 9 weeks after, the 1080 baiting.
- Images from the cameras were viewed manually and animal visits were characterised by date, time, species, and number of individuals. The numbers of visits and visitors were used to compare changes in species' relative abundances before and after toxic baiting, taking into account 'natural' (i.e. not related to 1080) changes in these indices in the untreated area.

Results

- ***Overall:*** More than 400,000 images were collected, which captured 6,059 visits and 6,267 visitors. The most common visitors were possums (2,081 visitors), followed by kiwi (1,626 visitors), then white-tailed deer (1,292 visitors). Deer were photographed at 175 of the 230 camera sites analysed (76%).
- ***White-tailed deer.*** The deer count per camera-week declined in all areas post-control, but with much larger decreases in activity in both of the treatment areas compared to the untreated area. The data strongly suggest an effect of toxic bait, after accounting for the area + time effects, with an estimated decrease in deer activity of 96.9% (95% CI = 91.1–99.0%) in the standard 1080 area and 74.7% (95% CI = 46.7–90.0%) in the deer-repellent 1080 area.
- ***Possums.*** The possum count per camera-week was similar in all three areas prior to control. The data strongly suggest an effect of toxic bait after accounting for the area + time effects, with an estimated decrease in possum activity of 98.0% (95% CI = 92.4–99.5%) in the standard 1080 area and 98.1% (95% CI = 92.7–99.6%) in the deer-repellent 1080 area.
- ***Rats.*** Three times as many rats were detected in the deer-repellent 1080 area pre-control compared to the other areas. Decreases in activity were similar in both treated areas, with an estimated decrease of 96.7% (95% CI = 89.0–99.4%) in the standard 1080 area and 96.9% (95% CI = 92.8–99.0%) in the deer-repellent 1080 area post-control.
- ***Feral Cats.*** Cats were occasionally photographed in all three areas pre-control (21–30 visits per area). None were photographed in either of the treated areas post-control, which

represents an estimated decrease of 98.4% (95% CI = 80.8–100%) in the standard 1080 area, and 98.7% (95% CI = 84.7–100%) in the deer-repellent 1080 area.

- ***Kiwi.*** The count per camera-week remained the same in all areas post-control. After accounting for area + time effects, there was no evidence for an effect of toxic bait on kiwi activity.

Conclusions

- There was high white-tailed deer by-kill with both Pronature™ Possum & Rodent 1080 bait and Prodeer® Possum + Rat 1080 bait. Although there was some evidence of a repellent effect of the Prodeer on white-tailed deer, our monitoring suggests that approximately three-quarters of the resident deer in the deer-repellent 1080 area were killed.
- The study area is occupied by small-bodied deer living in degraded habitat, which appears to have heightened their vulnerability to aerial 1080 baiting. With a population reduction of this scale it will likely take several years for the deer population to recover to pre-control densities depending on immigration rates and in situ breeding.
- Both bait types had very high control efficacy against possums and rats. Most of the rats photographed appeared to be ship rats but probably included some kiore as well.
- No feral cats were photographed in either treatment area after baiting, indicating a very high secondary kill of this species.
- Kiwi were relatively common in all study areas, and their visitation rate did not change after toxic baiting, which suggests their population was unaffected by the control operation.

Recommendations

- This trial showed that despite evidence of a repellent effect of Prodeer 1080 compared to Pronature 1080, overall repellency to white-tailed deer on Rakiura / Stewart Island when using Prodeer 1080 bait was low. If further aerial 1080 baiting operations are carried out on Rakiura / Stewart Island, deer by-kill can be expected. If stakeholders wish to minimise deer by-kill, it may be worth investigating if the other deer-repellent bait types (e.g. Pestex) are available and could be more effective.
- If desired, monitoring the recovery rate of the white-tailed deer in the treated areas could be undertaken to inform stakeholders. This could be done by rerunning the camera monitoring at the same time of year (August to October) in the next 2 years and comparing visitor rates. Recovery of targeted pest species could also be assessed using this method.

1 Introduction

The Bioeconomy Science Institute (BSI) was commissioned by Zero Invasive Predators Ltd (ZIP), on behalf of Predator Free Rakiura, to assess the non-target impact of aerial 1080 baiting on white-tailed deer (*Odocoileus virginianus*) on Rakiura / Stewart Island. The work was undertaken between March and December 2025.

2 Background

White-tailed deer were introduced to Rakiura / Stewart Island as a hunting resource in 1905 (Nugent 2005). They were initially protected to help them establish, but licensed hunting then began in 1919. Despite this their numbers increased rapidly, and in 1926 all protection was removed and official culling was carried out in the following decades (Nugent 2005), including a foliage baiting trial using 1080 gel in the 1980s s9(2)(g)(ii) 1990).

Since then, most white-tailed deer have been harvested by recreational hunters. A 1988 survey estimated that 1,500 deer were taken that year (Nugent 1992). More recently, between 2018 and 2022 hunters harvested just over 1,000 white-tailed deer each year from Public Conservation Land (i.e. excluding harvest on Rakiura Māori Land Trust blocks) (Game Animal Council 2023).

Predator Free Rakiura aims to permanently remove rats, possums, feral cats, and hedgehogs from the island. Although white-tailed deer have an impact on the native biodiversity of Rakiura / Stewart Island, they are not being targeted for control or eradication because they are valued as a recreational and economic resource by some members of the community. Aerial 1080 baiting, which the Department of Conservation (DOC) and ZIP propose to use as part of the Predator Free Rakiura programme, can result in unintended deer by-kill (Morriss, Parkes et al. 2020). Although data are sparse, white-tailed deer by-kill was noted during aerial 1080 carrot baiting for possums on Rakiura / Stewart Island in the 1970s s9(2)(g)(ii) 1990), and more recently when cereal 1080 bait was used in Dart Valley, Lake Wakatipu, in 2014 (Morriss, Parkes et al. 2020; Pinney et al. 2021).

In the early 2000s research in New Zealand identified a repellent that, when added as a surface coating to carrot or cereal 1080 bait (for rodents and possums), changed the appearance and smell of the bait in a way that successfully repelled deer while remaining palatable to the target species (see background in s9(2)(g)(ii) 2021). In recent years two bait manufacturers have developed commercial cereal baits with deer repellent incorporated into the bait rather than added as a coating. One of these is Prodeer® Possum + Rat Bait (manufactured by Orillion), which is the repellent bait assessed in this study.

There is good operational evidence of repellency with this Prodeer bait with red and sika deer (s9(2)(g)(ii) 2022, 2023; s9(2)(g)(ii) 2021), but there are limited efficacy data for white-tailed deer. In 2022, Prodeer bait was used in an aerial 1080 baiting operation for rat and stoat control in Dart Valley, Lake Wakatipu, where white-tailed deer are present. The New Zealand Game Animal Council carried out observational monitoring of this operation, and also conducted trials with non-toxic Prodeer bait and captive white-tailed deer. The results suggested that Prodeer bait may have been repellent to white-tailed deer s9(2)(g)(ii), New Zealand Game Animal Council, pers. comm., 30 July 2025).

In early 2025 a trial was conducted on Rakiura / Stewart Island to assess whether non-toxic Prodeer® Possum + Rat Bait is repellent to free-ranging white-tailed deer s9(2)(g)(ii) 2025). This preliminary trial was inconclusive. Deer were seen sniffing near repellent and non-repellent bait on

74 occasions, but only one weathered repellent bait was potentially eaten. No meaningful bait consumption was recorded during the trial, but it was recognised that possums and rats removed most bait before deer encountered it.

In winter 2025, ZIP in partnership with DOC conducted an aerial 1080 operation on Rakiura / Stewart Island to protect pukunui / Southern New Zealand dotterel. The operation aimed to control feral cats which are the primary predator of pukunui. While the pukunui recovery operation was a standalone response to an immediate conservation crisis, it also presented an opportunity to learn about impact of standard and repellent bait on white-tailed deer populations. Deer repellent was used within bookable hunting blocks under the treatment area. Deer repellent was requested for use in all areas possible by leadership for the New Zealand Deerstalkers Association and Game Animal Council, along with experienced local hunters, to reduce impact on deer populations in the blocks. It should be noted that prior to this trial, the effectiveness of using deer repellent with white-tailed deer populations was not well understood.

This trial aimed to assess the impact of aerial 1080 baiting for pest control on Rakiura / Stewart Island white-tailed deer by monitoring deer with trail cameras in two treatment areas (one with Prodeer® Possum + Rat deer-repellent 1080 bait and the other with Pronature™ Possum & Rodent standard 1080 bait) and in a non-treatment area where no toxic bait was used.

3 Objective

To determine and compare the non-target impacts on white-tailed deer of (i) standard Pronature™ Dry Forest 1080 cereal bait and (ii) Prodeer® Possum + Rat deer-repellent 1080 cereal bait, when used for pest control on Rakiura / Stewart Island.

4 Methods

4.1 Study areas and baiting operations

Direct estimates of the population size of free-ranging deer are prohibitively expensive to obtain. We therefore used the established method of monitoring using trail cameras, whereby changes in activity are used as a proxy for changes in population size. A non-treatment area was included in the design to account for seasonal changes in activity that are not due to the baiting operation.

Based on a power analysis (Appendix 1), we estimated that a minimum of c. 80 cameras per area were required to achieve statistical power of >0.8. For comparison, a minimum 30% change in relative abundance could be reliably detected with 40 cameras per area, whereas it did not appear feasible to reliably detect changes in relative abundance of only 10% using camera monitoring.

4.1.1 Study areas

The aerial 1080 operation planned by DOC and ZIP to protect pukunui / southern New Zealand dotterel on Rakiura / Stewart Island comprised c. 40,000 ha of the central part of the island, divided into the operational areas shown in Figure 1. Pronature™ Possum & Rodent 1080 standard bait was used for the majority of the operation (32,089 ha), with Prodeer® Possum + Rat 1080 deer-repellent bait used in the bookable hunting blocks at Doughboy Bay, South West Arm, and North Pegasus (8,441 ha). Within the overall operational area, a smaller 5,770 ha area received two

operational phases as part of the ZIP '1080 to Zero' trial (labelled as 'Eradication trial area' in Figure 1). There was no formal deer monitoring in the Eradication trial area.

The habitat in the areas monitored consisted of four main vegetation associations: lowland podocarp-broadleaved forest, mixed indigenous scrub, leptospermum scrub or fern, and pakihi heathland. The altitude in the areas treated ranged from 0 to 750 m asl.

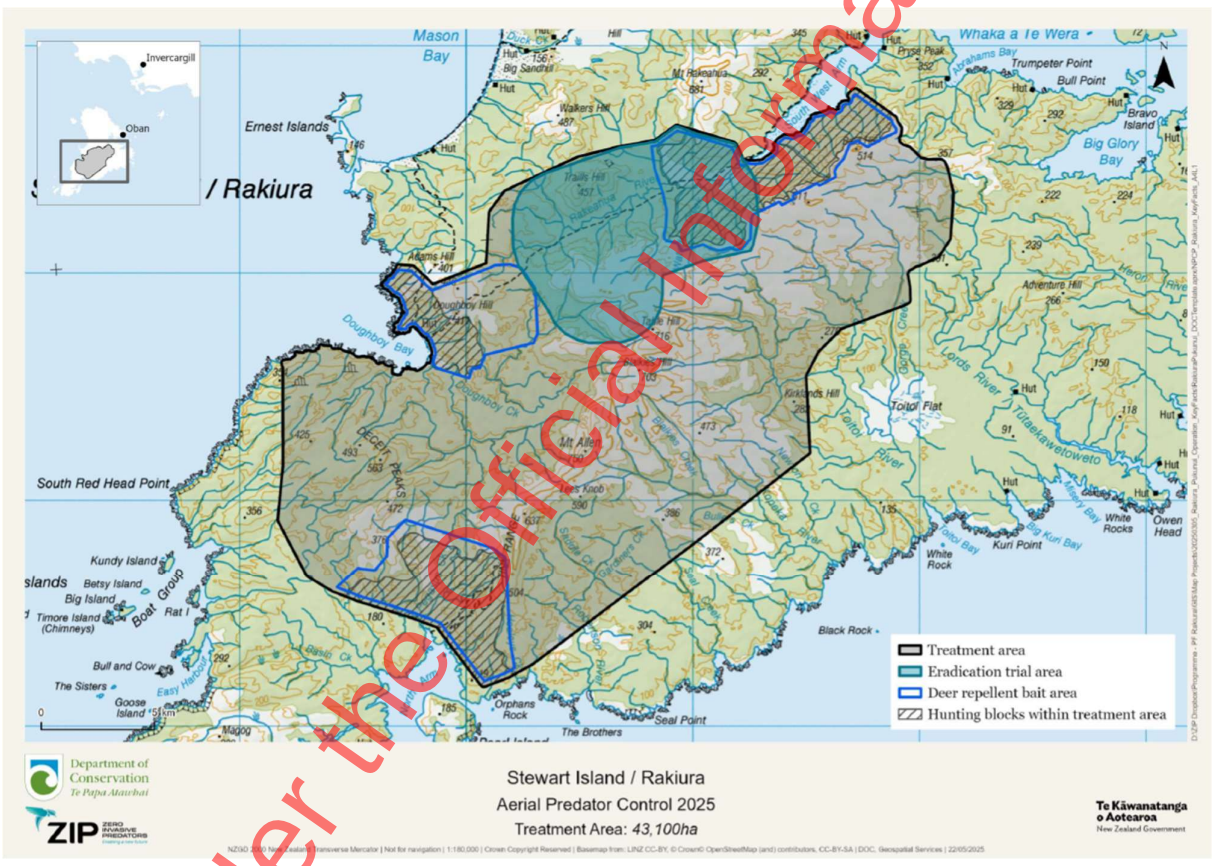

Figure 1. Predator control operational areas on Rakiura / Stewart Island during winter 2025. The operation aimed to reduce predation risk to pukunui / southern dotterel by reducing the number of feral cats, possums, and rats.

4.1.2 Baiting operations

The operational areas were pre-fed once (3 & 4 August 2025) with non-toxic 16 mm (6–8 g), cinnamon lured pre-feed bait broadcast at 2 kg/ha: Prodeer® Possum + Rat Bait and the same non-toxic bait without deer repellent. This was followed by Prodeer® Possum + Rat 1080 bait or Pronature™ Possum & Rodent 1080 bait (16 mm 6–8 g cinnamon lured cereal baits, hereafter called standard bait), broadcast at 2 kg/ha 18–19 days later (21 & 22 August 2025).

There were three fine nights after prefeed baiting before up to 10–15 mm of rain was recorded, followed by another five fine nights. Approximately 50–75 mm of precipitation was recorded between prefeed and commencement of toxic baiting. There were six fine nights after toxic baiting before 8.2 mm of rain was recorded. Over 200 mm of precipitation was recorded during the following 6 weeks.

4.2 Monitoring design and assessment of outcomes

4.2.1 Camera trapping

In July 2025, prior to aerial baiting, 242 trail cameras (Browning Dark Ops DCL Nano, Alabama, USA) were deployed by ZIP staff in the deer-repellent 1080 area (*n* = 80), in the standard 1080 area (*n* = 82), and in the non-treatment area (*n* = 80). Cameras were deployed systematically in grids, with about 300 m between them, and were placed at least 1.5 km from treatment area boundaries (Figure 2), with camera grids placed approximately 3 km apart to minimise risk of deer moving between treatments. The cameras were set to record a five-photo burst when an animal was detected, with a 1 second delay between bursts.

Approximately 85% of the installed cameras were placed in deer-preferred lowland podocarp-broadleaved forest, with the rest placed in adjacent mixed indigenous scrub. Most (200) cameras were serviced (memory cards and batteries replaced) between 9 and 13 October 2025, 7–8 weeks after toxic baiting. The remaining 42 cameras in the non-treatment area were serviced on 9 November 2025 due to weather-related delays.

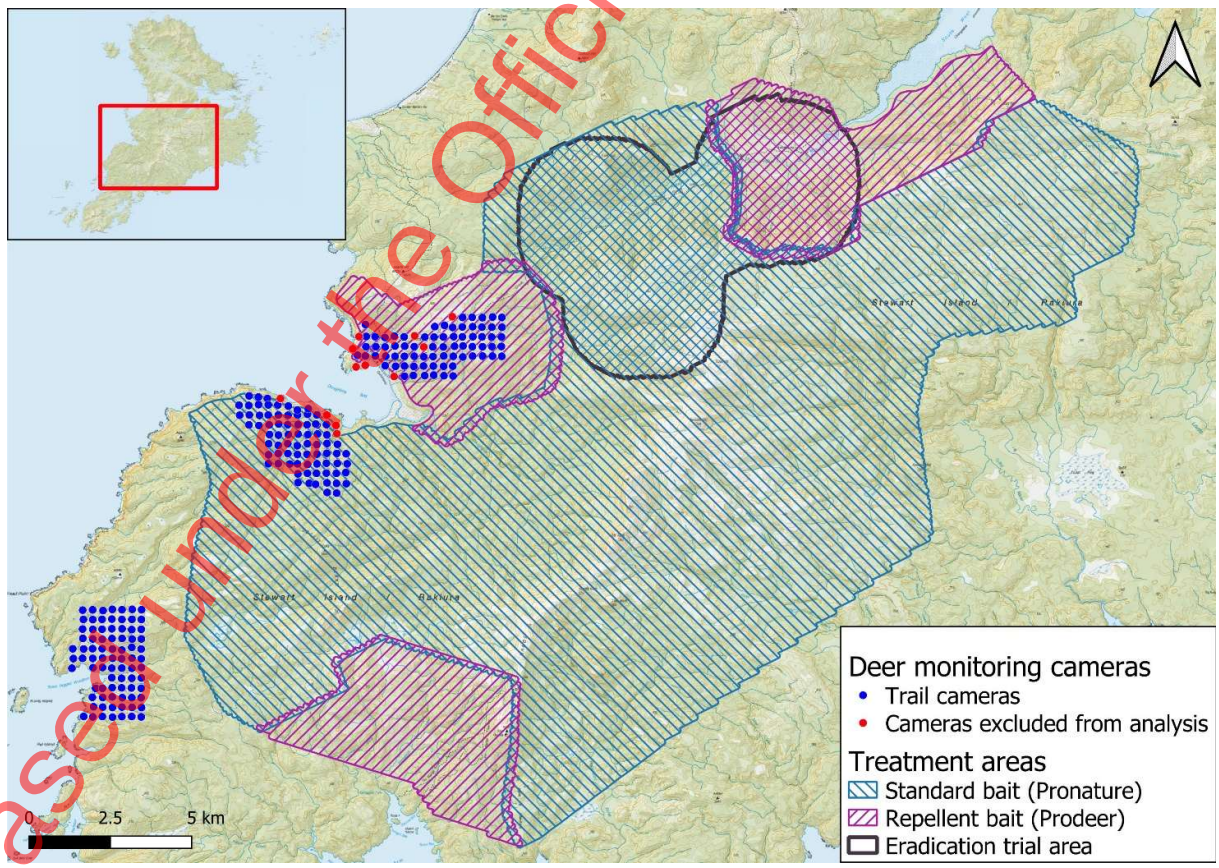

Figure 2. Camera monitoring grids in non-treatment area (lower left), Pronature standard 1080 bait area (blue cross-hatch), and Prodeer deer-repellent bait area (red cross-hatch), in the central part of Rakiura / Stewart Island. Cameras were deployed 3 to 6 weeks before toxic baiting on 21 & 22 August 2025 and then serviced, with SD cards collected, 7 to 9 weeks after. Cameras coloured red were excluded from analyses because they were either in the unbaited strip next to the sea or did not collect any photos due to malfunction.

Cameras were secured to trees at 1–1.5 m above the ground and pointed at an area where deer were most likely to pass in front of the camera. Most cameras (92%) remained functioning for the full survey period, but some may have stopped prematurely (twelve pre-baiting and eight post-baiting, although these probably include some cameras where field staff did not get photographed during the service visit even though the camera was functioning). The date of the final photograph was used as a (conservative) stop date for these cameras. Two cameras did not record photos due to corrupted SD cards, and one camera was not found during the service visit (all three were in the deer-repellent 1080 area). Following engagement with Southland Marine Farmers Association and CRA8 (on behalf of wild catch fisheries), there was an operational baiting set-back from the shoreline to ensure no 1080 bait was sown directly into the ocean. Nine cameras deployed in this unbaited strip were excluded from further analyses (deer-repellent 1080 n = 5, standard 1080 n = 4).

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 number of visits was determined by classifying any image of individual(s) separated by more than 5 minutes from any other image of that species as a separate 'visit', The number of visitors was determined by counting the number of different animals observed within each visit. Note that individual deer could be recorded on multiple visits, and the same individual could also be photographed by different cameras.

Cameras were active for 3–6 weeks before the toxic baiting dates of 21 & 22 August 2025 (depending on the area) and for 3 months thereafter. The activity metric used was visitors per camera-week for each 7-day period over the duration of the study. To compare the pre- vs post-toxin effects, information from up to 4 weeks pre- vs 4 weeks post-toxin were used for consistency between the three areas. All activity measures were calculated separately for the three areas.

The pre vs post data were analysed using a Bayesian generalised linear mixed model of the count of visitors per camera per week, with Poisson distributed errors and an offset term for the number of cameras per week in each area to account for the different monitoring effort between areas. We included main effects of 'area' (non-treatment vs deer-repellent 1080 vs standard 1080) and 'time' (pre vs post), the area + time interaction between them (i.e. the effect of 'toxic baiting'), as well as a random effect of camera. This model specification and the inclusion of a non-treatment area allowed us to explicitly account for changes in animal activity before and after baiting that were unrelated to the 1080 operation. If activity declined (after accounting for area and time), the change was interpreted as an estimate of percentage kill.

The analysis was carried out using R (R Core Team 2021) with the analytical model specified in OpenBUGS 3.2.3 (Lunn et al. 2009). The model coefficients (intercept, time, area, baiting) all had vague informative priors of Normal(0, 10).

5 Results

5.1 Species recorded

In total 401,768 photos were taken. Three-quarters of these were false triggers, predominantly caused by wind moving vegetation (i.e. the camera sensor detected movement and took a photo

when there was no animal present). We analysed 118,202 photos, which recorded 6,020 visits and 6,228 visitors. The most common visitor was possum (*Trichosurus vulpecula*) (2,081 visitors), followed by southern brown kiwi / tokoeka (*Apteryx australis*) (1,626 visitors), then white-tailed deer (1,292 visitors). Deer were photographed at 175 of the 230 camera sites analysed (76%). Rats (*Rattus spp.*) (828 visitors) and feral cats (*Felis catus*) (144 visitors) were also photographed. Several bird species were photographed, with blackbirds (*Turdus merula*) being the most common visitor (148 of 257 bird visitors). Note that the number of weeks of monitoring differed between pre and post monitoring, and also among areas.

Of the total images processed and summarised above, information from 4 weeks pre- and 4 weeks post-toxin were used to compare the pre- vs post-toxin effects (Table 1).

Table 1. Number of visitors recorded on trail cameras 4 weeks before (pre) and 4 weeks after (post) aerial baiting in a deer-repellent 1080 cereal bait area, a standard 1080 cereal bait area, and an adjacent non-treatment area on Rakiura / Stewart Island.

	Deer-repellent 1080		Standard 1080		Non-treatment	
Visitor	Pre	Post	Pre	Post	Pre	Post
White-tailed deer	81	22	214	6	242	291
Possum	383	5	394	7	304	328
Rat	209	5	77	2	80	71
Feral cat	19	0	15	0	30	37
Kiwi	108	123	93	112	220	320

To account for account for differences in monitoring effort, data were summarised in a visit rate metric - 'visitors per camera-week' (i.e. the mean number of animals seen per camera in a 7-day period) (Table 2).

Table 2. Number of visitors per camera-week recorded on trail cameras 4 weeks before (pre) and 4 weeks after (post) aerial baiting in a deer-repellent 1080 cereal bait area, a standard 1080 cereal bait area, and an adjacent non-treatment area on Rakiura / Stewart Island

	Deer-repellent 1080		Standard 1080		Non-treatment	
Visitor	Pre	Post	Pre	Post	Pre	Post
White-tailed deer	0.26	0.06	0.61	0.01	0.81	0.90
Possum	1.20	0.01	1.18	0.04	1.13	1.05
Rat	0.79	0.06	0.26	0.03	0.28	0.23
Feral cat	0.05	0.00	0.06	0.00	0.11	0.10
Kiwi	0.38	0.42	0.30	0.40	0.75	0.95

5.2 Changes in visit rates

5.2.1 Change in white-tailed deer visit rate

Deer activity, as measured by the number of visitors per camera-week, was variable within areas during the pre-control phase, but overall was higher in the non-treatment and standard 1080 areas compared with the deer-repellent 1080 area. Deer visitors per camera-week dropped sharply post-control in both the deer-repellent 1080 (pre = 0.26 vs post = 0.06) and standard 1080 (pre = 0.61 vs post = 0.01) areas while remaining relatively constant in the non-treatment area (pre = 0.81 vs post = 0.90) (Appendix 2).

After accounting for time and area effects, there was strong evidence for a pronounced effect of toxic bait on white-tailed deer in both treatment sites, with an estimated decline of 74.7% (95% credible interval [CI] = 46.7–90.0) in the deer-repellent 1080 area and 96.9% (95% CI = 91.1–99.0) in the standard 1080 area. The wide CI in the deer-repellent 1080 area is due to the smaller number of photographs in this area. There is very strong evidence for a repellency effect on white-tailed deer: the probability that the decline due to standard 1080 was greater than the decline due to deer-repellent 1080 is 0.999.

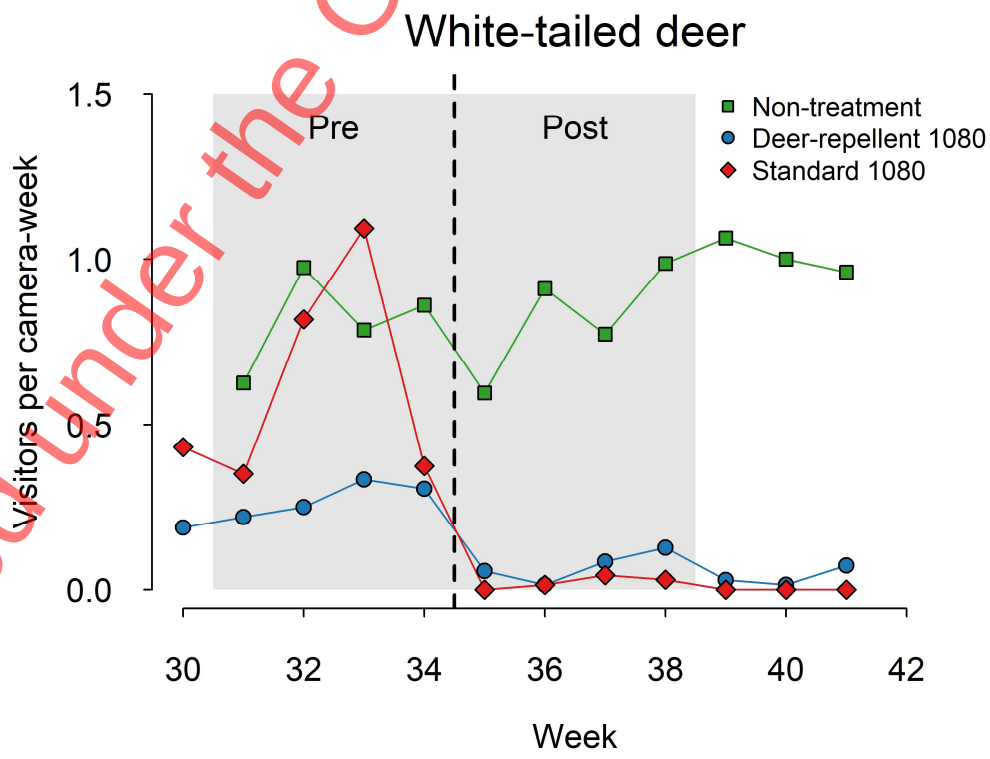

Figure 3. Mean visitors per camera-week for white-tailed deer in each area for each 7-day interval during the camera survey. The dashed line indicates the timing of baiting with Pronature standard 1080 cereal bait and Prodeer deer-repellent 1080 cereal bait. The shaded area indicates the pre and post time periods used for analysis.

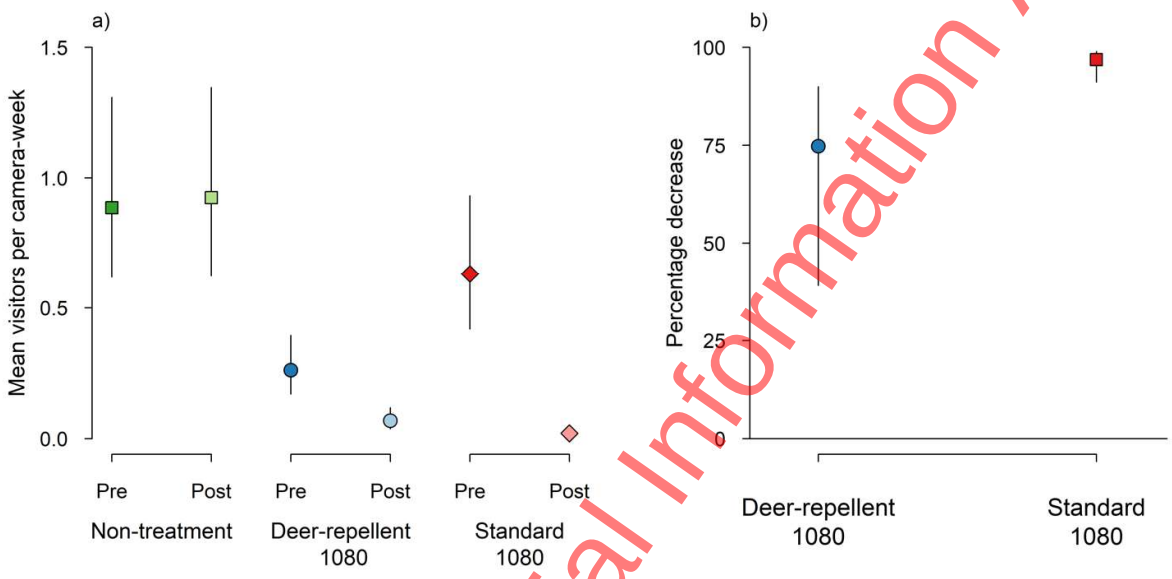

Figure 4. (a) Mean counts of visitors per camera-week (±95% CI) for white-tailed deer in the non-treatment, Prodeer deer-repellent 1080, and Pronature standard 1080 areas based on 4 weeks pre- and post-baiting; (b) percentage decrease attributable to toxic bait.

5.2.2 Change in possum visit rate

Possum activity was variable over time during the pre-control phase, but similar in both treatment sites. As with deer, possum numbers dropped sharply post-control in both the deer-repellent 1080 (pre = 1.20 vs post = 0.01) and standard 1080 (pre = 1.18 vs post = 0.04) areas while remaining relatively constant in the non-treatment area (pre = 1.13 vs post = 1.05). After accounting for time and area effects, there was strong evidence for an effect of toxic bait on possum activity in both treatment areas, with an estimated decline of 98.0% (95% CI = 92.4–99.5) in the deer-repellent 1080 area, and a decline of 98.1% (95% CI = 92.7–99.6) in the standard 1080 area. There is no evidence for a repellency effect on possums: the probability that the decline due to standard 1080 bait was greater than the decline due to deer-repellent 1080 is 0.46.

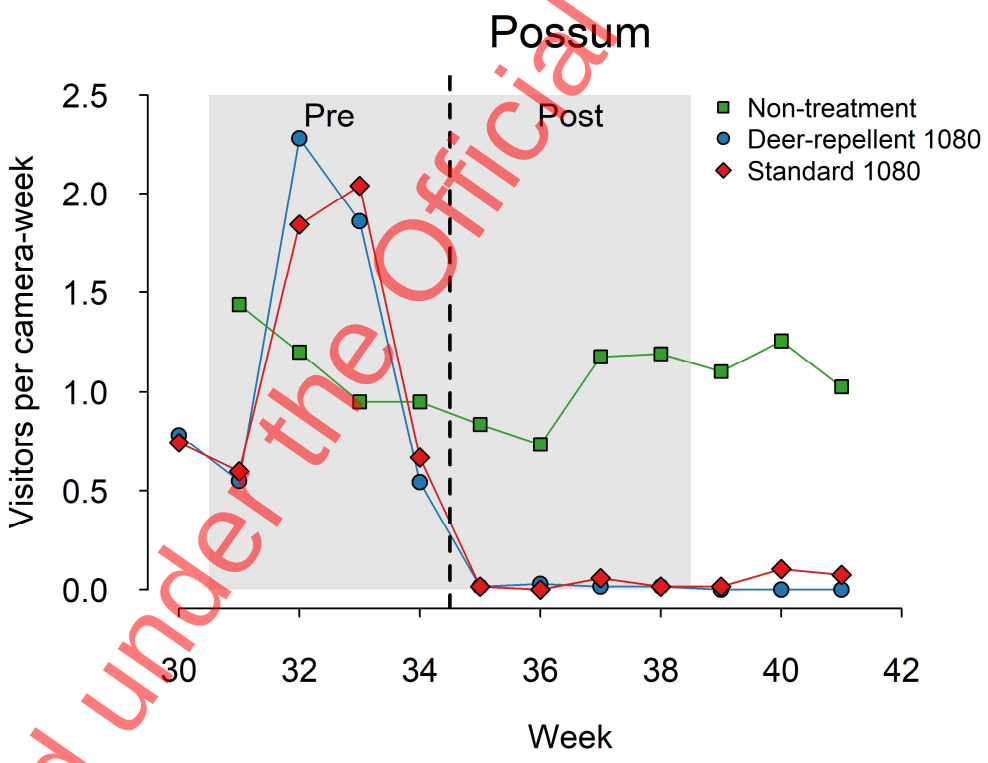

Figure 5. The mean number of visitors per camera-week for each 7-day period for possums throughout the duration of the monitoring in each area. The dashed line indicates the timing of baiting with Pronature standard 1080 cereal bait and Prodeer deer-repellent cereal 1080 bait. The shaded area indicates the pre and post time periods used for analysis.

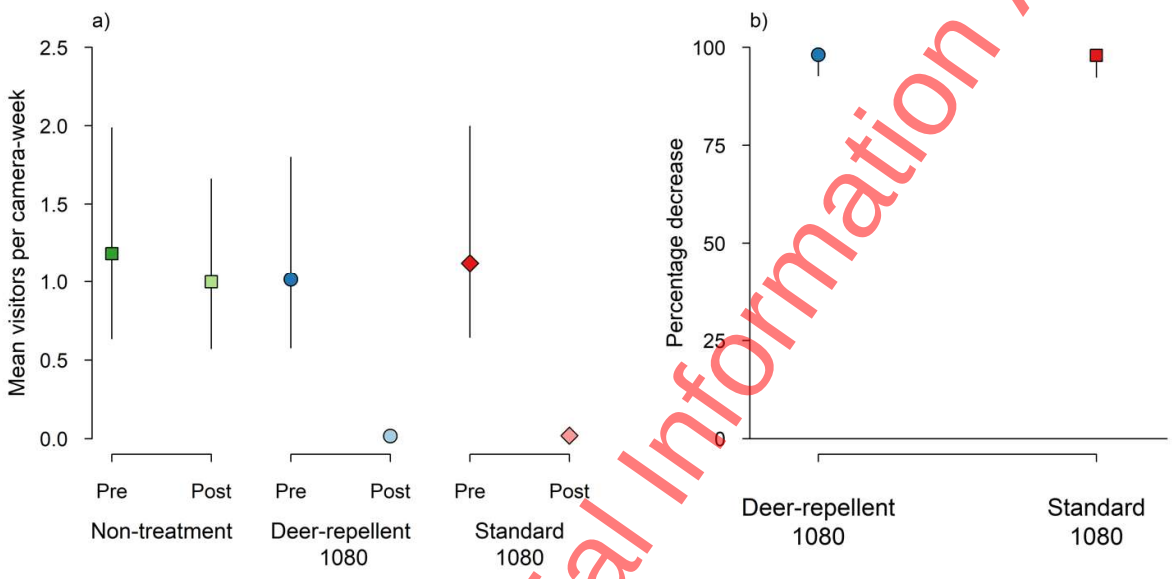

Figure 6. (a) Mean number of visitors per camera-week (95% CI) for possums in the non-treatment, Prodeer deer-repellent 1080, and Pronature standard 1080 areas, based on 4 weeks pre- and post-baiting; (b) percentage decrease attributable to toxic bait.

5.2.3 Change in rat visit rate

Rat activity had similar indices of pre-control activity in the non-treatment and standard 1080 sites, with a higher rate of activity in the deer-repellent 1080 site. Rat activity dropped sharply post-control in both the deer-repellent 1080 (pre = 0.79 vs post = 0.06) and standard 1080 (pre = 0.26 vs post = 0.03) areas while remaining relatively constant in the non-treatment area (pre = 0.28 vs post = 0.23).

After accounting for time and area effects, there was strong evidence for an effect of toxic bait on rats in both treatment areas, with an estimated decline of 96.7% (95% CI = 89.0–99.4) in the deer-repellent 1080 area, and a decline of 96.9% (95% CI = 92.8–99.0) in the standard 1080 area. Increases in rat activity were observed in both treatment areas 4–5 weeks after control. There is no evidence for a repellency effect on rats: the probability that the decline due to standard 1080 was greater than the decline due to deer-repellent 1080 is 0.46.

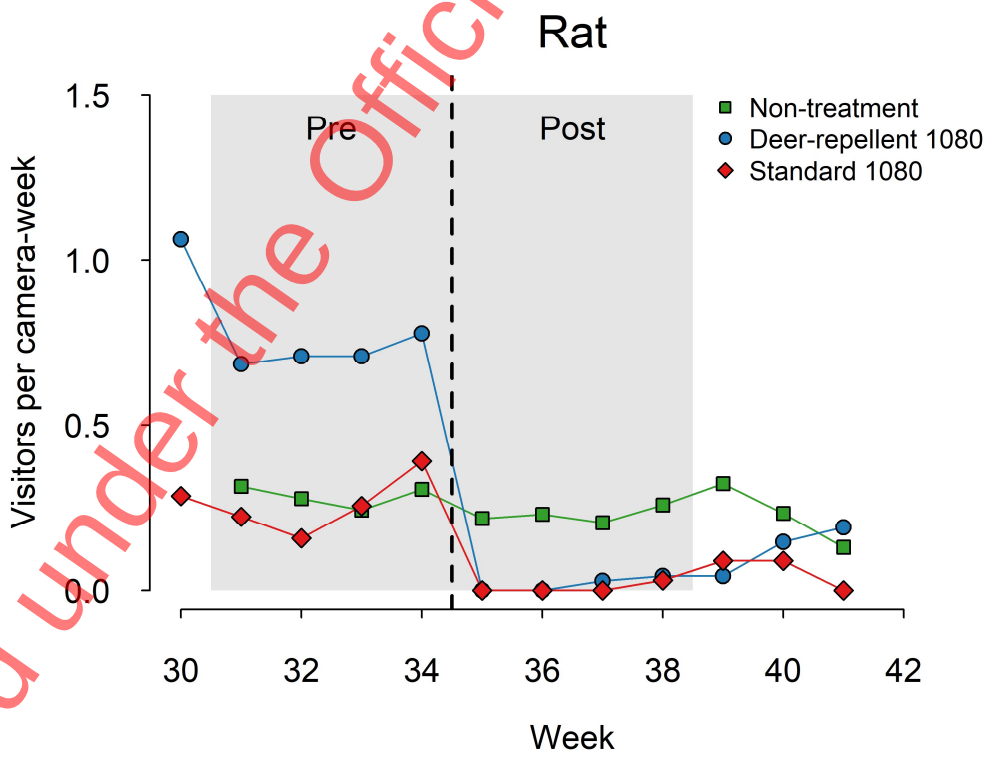

Figure 7. The mean number of visitors per camera-week for each 7-day period for rats throughout the duration of the monitoring in each area. The dashed line indicates the timing of the baiting with Pronature standard 1080 cereal bait and Prodeer deer-repellent cereal 1080 bait. The shaded area indicates the pre and post time periods used for analysis.

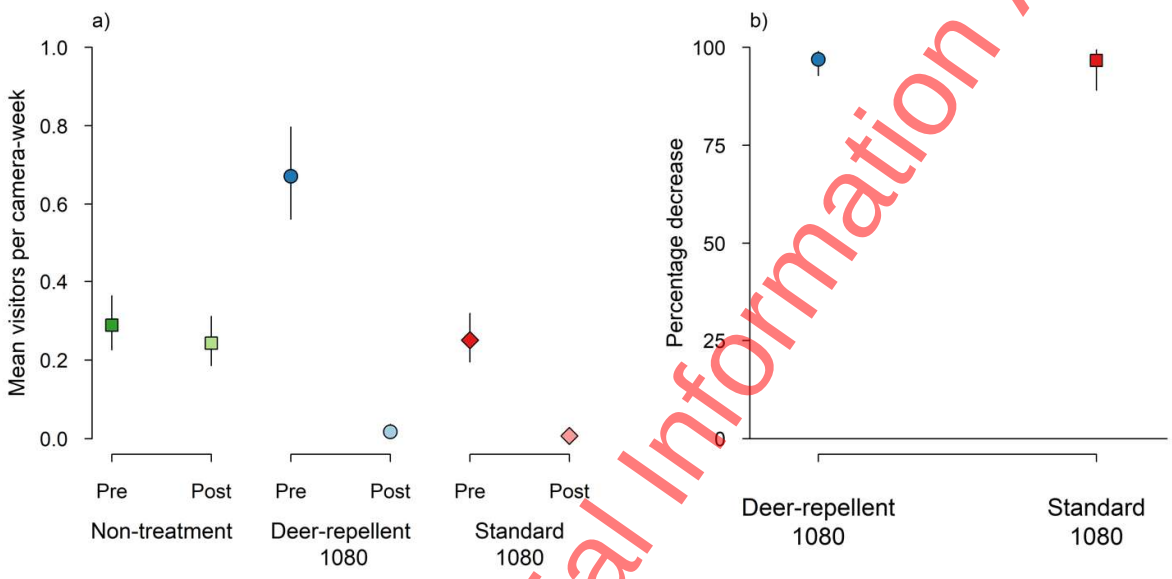

Figure 8. (a) Mean number of visitors per camera-week (95% CI) for rats in the non-treatment, Prodeer deer-repellent 1080, and Pronature standard 1080 areas, based on 4 weeks pre- and post-baiting; (b) percentage decrease attributable to toxic bait.

5.2.4 Change in feral cat visit rate

Feral cats had similar indices of pre-control activity in all three areas. Activity remained relatively identical in the non-treatment site (pre = 0.11 vs post = 0.10), but dropped to zero post-control in both the deer-repellent 1080 (pre = 0.05 vs post = 0.00) and standard 1080 (pre = 0.06 vs post = 0.00) areas, with no feral cats detected in either baited area in the weeks post-control. After accounting for time and area effects, there was strong evidence for an effect of toxic bait on feral cats in both treatment areas, with an estimated decline of 98.4% (95% CI = 80.8–100.0) in the deer-repellent 1080 area, and a decline of 98.7% (95% CI = 84.7–100.0) in the standard 1080 area. There is no evidence for a repellency effect on feral cats: the probability that the decline due to standard 1080 was greater than the decline due to deer-repellent 1080 is 0.47.

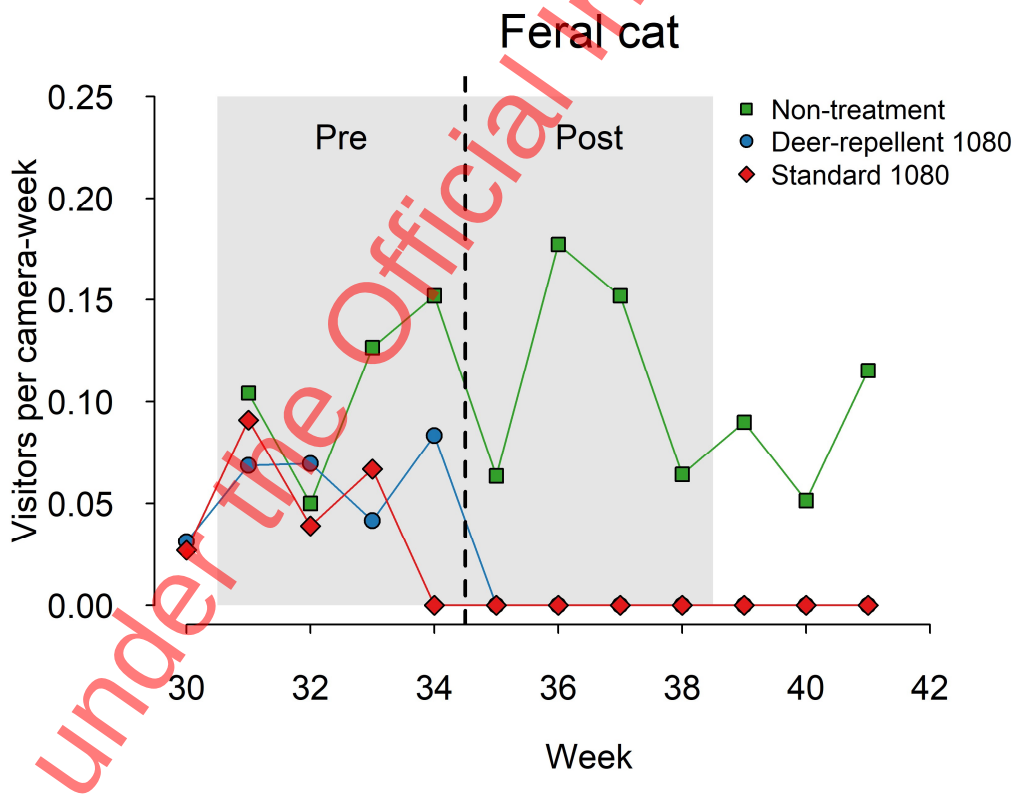

Figure 9. The mean number of visitors per camera-week for each 7-day period for feral cats throughout the duration of monitoring in each area. The dashed line indicates the timing of the baiting with Pronature standard 1080 cereal bait and Prodeer deer-repellent cereal 1080 bait. The shaded area indicates the pre and post time periods used for analysis.

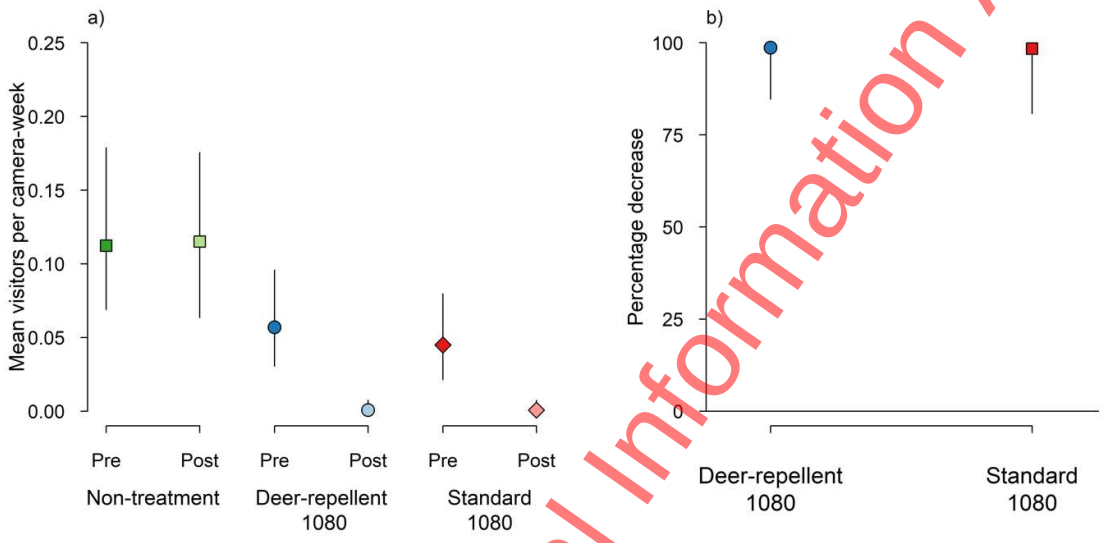

Figure 10. (a) The mean number of visitors per camera-week (95% CI) for feral cats in the non-treatment, Prodeer deer-repellent 1080, and Pronature standard 1080 areas, based on 4 weeks pre- and post-baiting; (b) percentage decrease attributable to toxic bait.

5.2.5 Change in kiwi visit rate

Kiwi had similar indices of pre-control activity in the treatment areas, with a higher observed rate of activity in the non-treatment area. Kiwi activity did not change in the treatment areas over the monitoring period and trended upwards in the non-treatment site (pre = 0.75 vs 0.95 post). After accounting for time and area effects, there was no evidence for an effect of toxic bait on kiwi, with the 95% CI of estimated change overlapping zero in both the deer-repellent 1080 bait area (95% CI = -34.6–42.2) and the standard 1080 bait area (95%CI = -48.2–38.5).

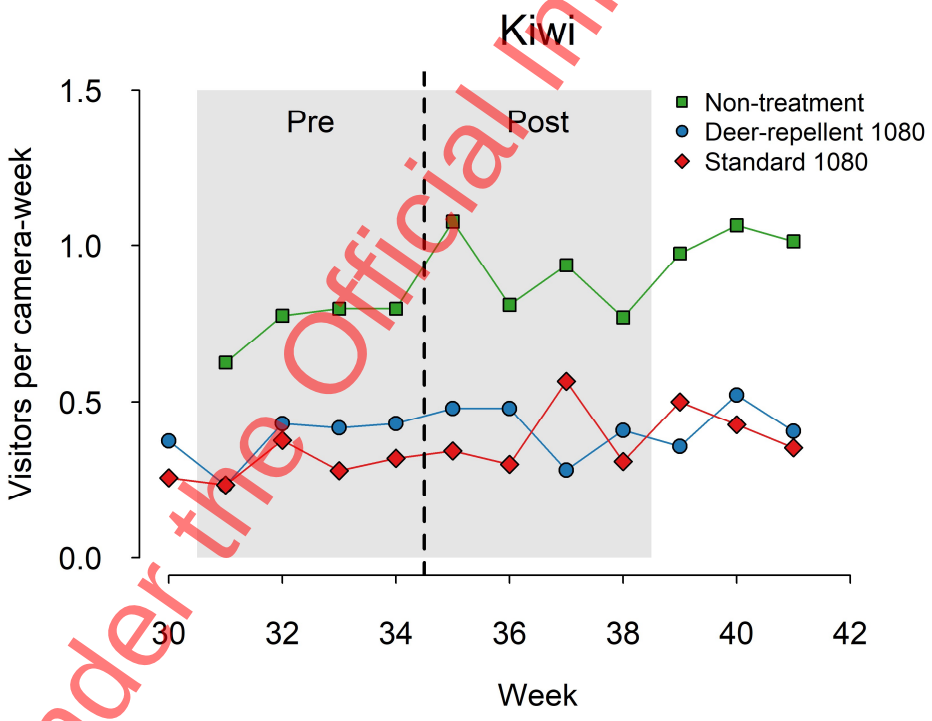

Figure 11. The mean number of visitors per camera-week for each 7-day period for kiwi throughout the duration of the monitoring in each area. The dashed line indicates the timing of the baiting with Pronature standard 1080 cereal bait and Prodeer deer-repellent cereal 1080 bait. The shaded area indicates the pre and post time periods used for analysis.

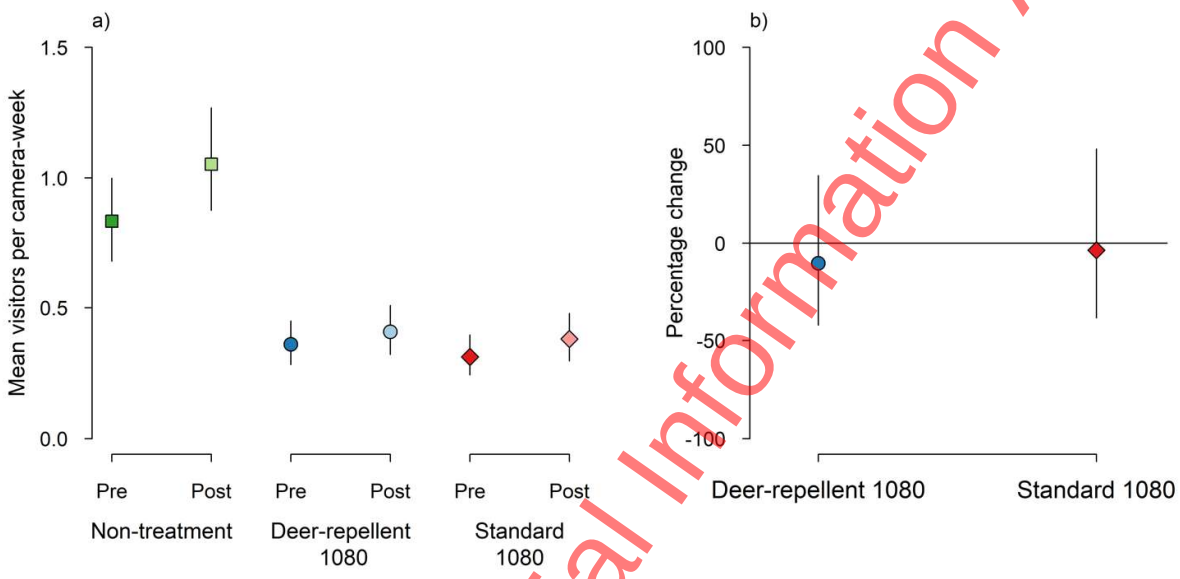

Figure 12. (a) The mean number of visitors per camera-week (95% CI) for kiwi in the non-treatment, Prodeer deer-repellent 1080, and Pronature standard 1080 areas, based on 4 weeks pre- and post-baiting; (b) percentage change attributable to toxic bait.

5.3 Incidental observations of carcasses

There were no formal carcass searches in the treatment areas, but one dead white-tailed deer was found by ZIP staff in the deer-repellent 1080 area during post-toxic bait camera servicing. No dead deer were found in the standard 1080 camera grid area.

6 Conclusions

6.1 White-tailed deer

There was a substantial decrease in white-tailed deer activity in both treatment areas. Assuming that changes in activity correspond to changes in population size, it is highly likely that there was a high white-tailed deer by-kill with both Pronature™ Possum & Rodent standard 1080 bait and Prodeer® Possum + Rat deer-repellent 1080 bait. There was strong evidence of a repellent effect of Prodeer bait when compared with Pronature bait (74.7% vs 96.9% reduction in visitor rate). The wide 95% CI in the deer-repellent 1080 area is due to the smaller number of photographs in this area.

A small number of cameras were excluded from the analysis due to them being placed in the coastal edge which was not baited as part of the aerial operation to protect pukunui. While these cameras did record some deer, it is worth noting that the visitor rate here declined at a similar rate to the rest of the trial area (i.e. an 80% reduction, albeit with a very small sample size). Because of this observed decline, we do not consider the unbaited area impacted the integrity of the analysis and results. The short time period of analysis (4 weeks post-baiting) is also expected to reduce the risk that immigration into the trial area is artificially inflating the deer presence recorded in the deer repellent area.

In 2017 about 62,000 ha of Molesworth Station was baited for possum control using standard 1080 cereal bait, with an estimated 91% reduction in the resident red deer (*Cervus elaphus*) s9(2)(g)(ii) [redacted] 2020). After three annual aerial counts (2018 to 2020) to gauge population change, it was estimated that the deer population would take 4 years after baiting to recover to pre-baiting levels due to a combination of *in situ* breeding and immigration from surrounding unbaited areas. This may give some indication of how quickly the white-tailed deer population in the treatment areas on Rakiura / Stewart Island will recover, although the likely rate of immigration by this species in this location is uncertain. The lowered deer density in the baited areas will increase the forage available for surviving deer, leading to better-condition deer with a higher reproductive output, which could accelerate population recovery. If stakeholders want to measure recovery rate of the white-tailed deer (and the pest species), then repeating camera monitoring during the same season (August to October) in 2026 and 2027 could be used to measure population trends. Additionally, a survey of hunter experience and success in the treated hunting blocks could help to understand if population reduction of white-tailed deer impacted hunting experience.

6.2 Predators

The cameras were set up to monitor deer and were un-lured, so they were probably sub-optimal for the smaller species, leading to relatively low detection rates. Nevertheless, there were enough possum, rat, and cat photos to provide indices of population reduction due to toxic baiting for all three species. Both bait types had very high control efficacy against these predators.

Three species of rat – Norway rat (*Rattus norvegicus*), ship rat (*Rattus rattus*), and kiore (*Rattus exulans*) – are present on Rakiura / Stewart Island. Most of the rats photographed appeared to be ship rats, but it is likely that some were kiore. None were obviously Norway rats.

No feral cats were photographed in either treatment area after baiting, suggesting a high secondary kill of this species. This achieved the results target of the aerial operation to protect pukunui, by providing a significant knockdown of their main predator during the 2025/2026 breeding season.

6.3 Kiwi

Kiwi were relatively common in all treatment areas (they were photographed by 57% of the cameras) and the kiwi visitor rate was unaffected by toxic baiting. Photos of juvenile kiwi were noted at four sites and courtship behaviour was photographed at 15 sites.

7 Recommendations

- This trial showed that despite evidence of a repellent effect of Prodeer 1080 compared to Pronature 1080, overall repellency to white-tailed deer on Rakiura / Stewart Island when using Prodeer 1080 bait was low. If further aerial 1080 baiting operations are carried out on Rakiura / Stewart Island, deer by-kill can be expected. If stakeholders wish to minimise deer by-kill ait may be worth investigating if the other deer-repellent bait types (e.g. Pestex) are available and could be more effective.
- If desired, monitoring the recovery rate of the white-tailed deer in the baited areas could be undertaken to inform stakeholders. This could be done by rerunning the camera monitoring at

the same time of year (August to October) in the next 2 years and comparing visitor rates. Recovery of targeted pest species could also be assessed using this method.

8 Acknowledgements

We thank ZIP's staff for conducting the field work and data management. Thanks to ZIP for funding this trial as part of the Predator Free Rakiura project. Thanks to s9(2)(g)(ii) for graphical support, s9(2)(g)(ii) for reviewing the report, s9(2)(g)(ii) for editing, and s9(2)(g)(ii) for final formatting of this report.

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Appendix 1 – Power analysis

Prior to the study a statistical power analysis was carried out to determine the number of cameras required to be set for 6 weeks pre- and post- toxic baiting to reliably detect specified reductions in white-tailed deer relative abundance. We carried out power analyses for five levels of 'number of cameras' and three levels of mean 'percent reduction'. For each of the resulting 15 combinations of camera + percent-reduction we simulated camera monitoring data for a range of levels of between- and within-camera variability. Between-camera variability accounts for the fact that within an area each camera may record different numbers of encounters due to local factors such as habitat and local scale distribution, whereas within-camera variability accounts for the variability in weekly counts for each camera. Three levels of both within- and between-camera variability were simulated, resulting in nine combinations of variability. A total of 500 iterations were performed for each combination of camera + percent-reduction and level of variability. A generalised linear model was specified to analyse the data and calculate the population reduction in the post-toxin period compared with the pre-toxin period. For this simulation-based approach, the statistical 'power' is calculated as the proportion of iterations where the *p*-value for the deer-repellent area was <0.05, indicating the detection of a statistically significant decrease in the post-toxin vs pre-toxin mean camera counts.

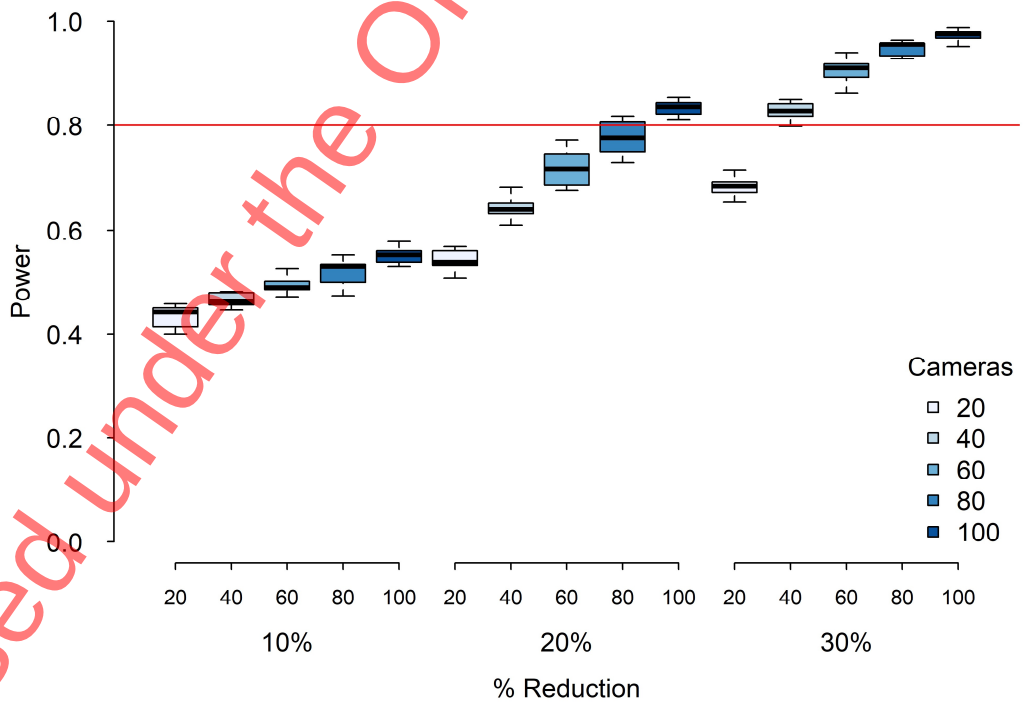


Figure A1. Results of a power analysis to detect different reductions in relative abundance of white-tailed deer using camera traps. The variability within each %reduction + camera-number combination is due to differences in assumed within- and between-camera variability.

Appendix 2 – Change in white-tailed deer visit rate

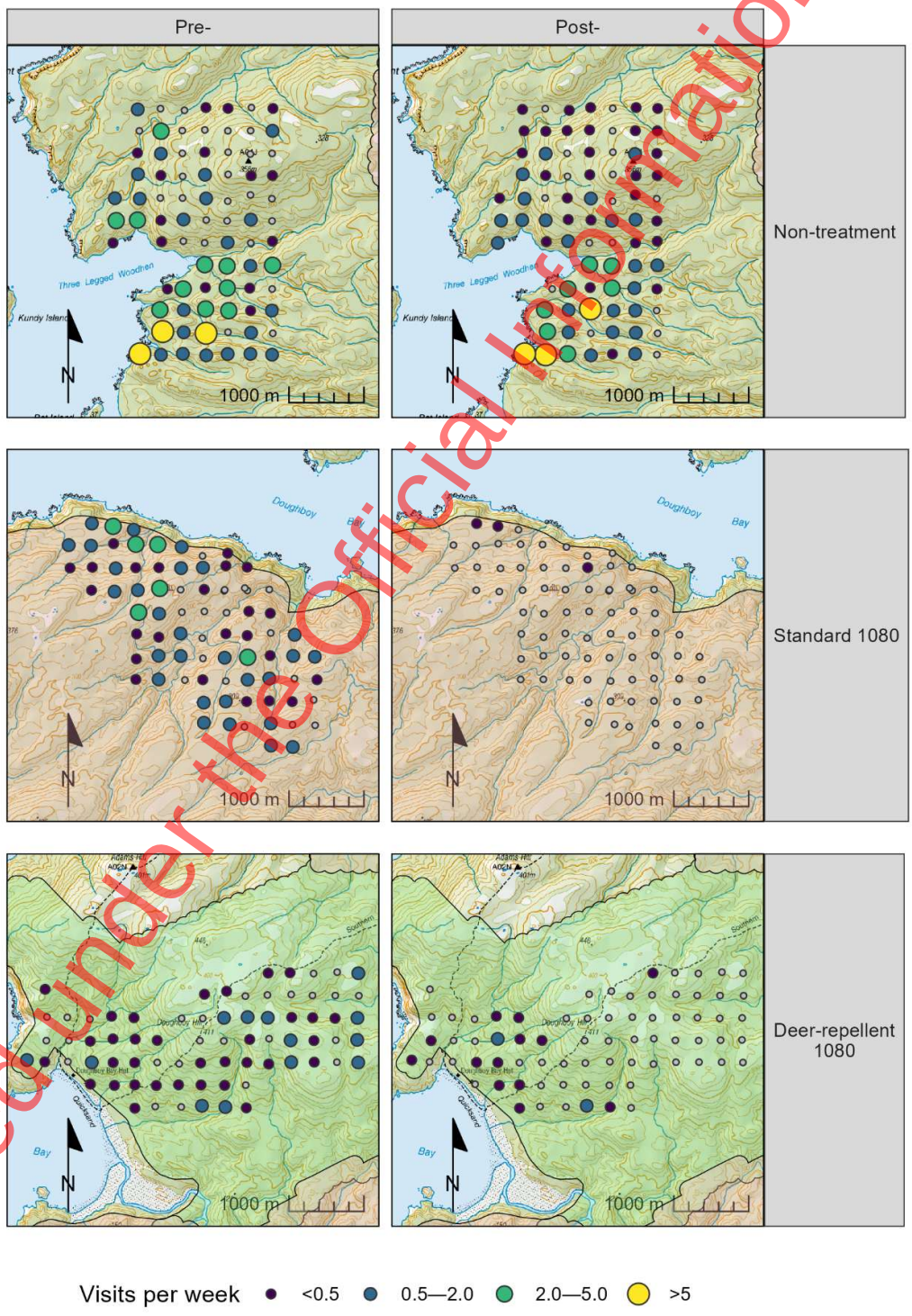


Figure A2. Maps showing the number of white-tailed deer visits per day recorded at each trail camera. Rows correspond to the different treatments, while columns indicate the pre- and post-control periods. Grey open circles mark the locations of cameras that recorded no visits during the monitoring period. Shading indicates the boundaries for the standard 1080 (orange) and deer-repellent 1080 (green) treatments.

Rakiura white-tailed deer study

The results are available from a study to learn more about the impact of 1080 bait on Rakiura white-tailed deer and the effectiveness of deer repellent.

Overview of the study

Last year, a study was done by the Bioeconomy Science Institute (BSI) (formerly Manaaki Whenua – Landcare Research) to assess the impact of 1080 bait on Rakiura white-tailed deer and the effectiveness of Prodeer repellent bait.

The study was commissioned by Predator Free Rakiura to help inform future operations targeting feral cats, rats and possums on the island.

It was done alongside the aerial 1080 operation by DOC in August to protect pukunui/southern New Zealand dotterel from extinction.

The operation covered 40,000 hectares of public conservation land. Standard 1080 bait was used across 32,000 ha and deer repellent bait was used across 8,400 ha.

242 movement-activated cameras were used across three monitoring grids. One camera grid was set up in the standard 1080 bait area and another in the deer repellent area. A third grid was set up outside the 1080 operational area to provide a comparison and to account for any seasonal changes in activity *(see the map on page 2)*.

The cameras were active for three-to-six weeks before the operation and remained in place for between seven and nine weeks after it.

By comparing the number of camera detections before and after the operation, researchers were able to measure changes to the relative abundance of white-tailed deer over the duration of the trial.

The study was not designed to do a deer population count, as some individual animals may have been detected multiple times.

This study is only applicable for white-tailed deer on Rakiura; the results do not reflect what is happening with other types of deer in predator control areas elsewhere in the country.

The results

118,202 photos were analysed, and they showed 6,059 detections of various species. The most common were possums (2,081 visits), followed by kiwi (1,626 visits), then white-tailed deer (1,292 visits). Deer were photographed at 175 of the 230 camera sites (76%).

Kiwi activity was high in all three areas, and the rate of kiwi detection didn't change after the operation. There was an estimated decrease in possum activity by 98.0%, rat activity by 96.7%, and feral cat activity by 98.4%.

On average, there was a 75% reduction in deer activity in the operational area where deer repellent was used in contrast with a 97% reduction in the operational area where standard 1080 bait pellets were used *(see the map on page 4)*. Deer detections remained relatively constant in the non-treatment area before and after the operation.

Other insights

The large majority of the Rakiura white-tailed deer population was unaffected. The operation covered four out of 35 hunting blocks on the island, and some remote open hunting areas.

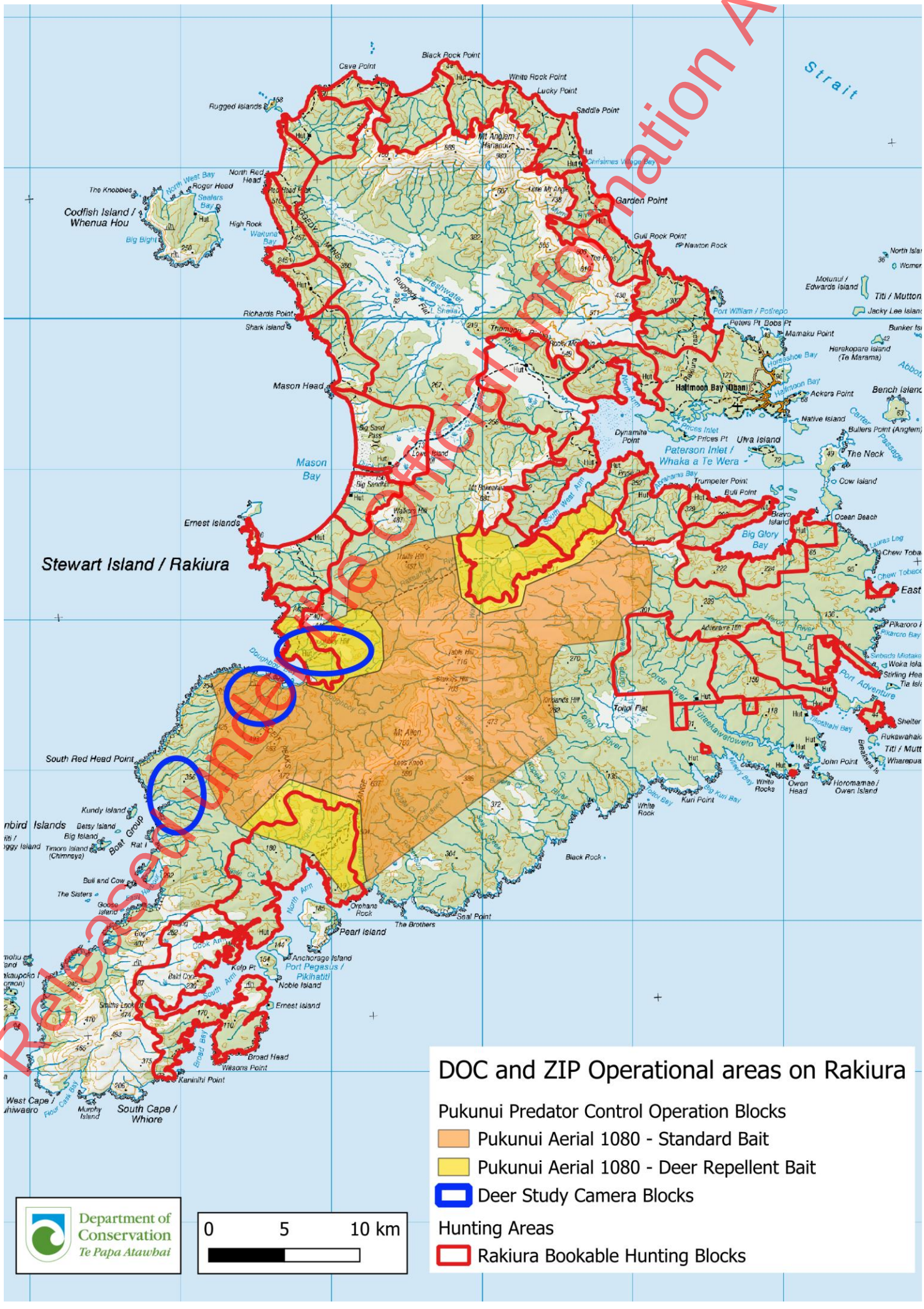
Outside the operational area, Rakiura still has a large and widely distributed population of white-tailed deer, as shown by the monitoring results in the non-treatment area.

Deer are still present in the coastal area at the edge of the operational boundary, and they will gradually re-enter and re-populate the wider operational area.

The lowered deer density in the operational area is expected to increase the forage available for surviving deer, leading to better-condition deer with a higher reproductive output, which could accelerate population recovery.

It is estimated that white-tailed deer will be widespread throughout the operational area, but in low numbers, within one year, and back to pre-operational levels in three-four years. This is based on other studies of population recovery for white-tailed deer and red deer.

Map showing camera grid locations and the operational area in relation to hunting blocks across the island



Comparing the results to other deer studies in New Zealand

The reduction in deer activity was higher than has been observed in some other deer monitoring studies elsewhere in New Zealand.

The report outlines some likely causes, including low natural food availability, meaning the deer were hungry and more likely to eat the bait pellets, and the small size of white-tailed deer making them more susceptible to eating a lethal dose of 1080.

Another probable factor is a lack of herd exposure to 1080 bait pellets previously, meaning the Rakiura white-tailed deer were less cautious of the baits than in areas where there have been multiple 1080 predator control operations.

The latest pukunui and feral cat monitoring information

DOC is continuing to monitor feral cats in the operational area. Numbers have remained low, with none spotted by trail cameras since the operation, and only three caught in traps, two of which were on the boundary of the operational area.

This has given vulnerable pukunui chicks a greater chance of successfully fledging and adult birds a better chance of surviving through the breeding season.

Pukunui appear to have had a successful breeding season following the aerial 1080 predator control operation, with 37 chicks and 80 eggs counted across 36 nests.

We will know the total pukunui population change in April when the Rakiura DOC team does the annual flock count. The results will be shared once they are available.

A banded Pukunui/Southern NZ dotterel. DOC will begin banding juvenile pukunui in March once most of the birds have journeyed down to the coast to flock.

Next steps

As recommended in the report, DOC will monitor the movement of white-tailed deer back into the operational area and share the results as they become available. DOC will use its existing trail camera network which is also monitoring feral cats.

There are no aerial 1080 operations planned on Rakiura in 2026 following the successful pukunui predator control operation, and while Predator Free Rakiura considers the next steps for the project following the eradication trial last year.

There will be further engagement to come with the project partners and local and national stakeholders on these next steps.

Other updates

The caution period for hunting for meat in the operational area is expected to be lifted by the end of February as predator carcasses have nearly degraded to a safe level.

For more information

If you have any unanswered questions, please email: **info@predatorfreerakiura.org.nz**

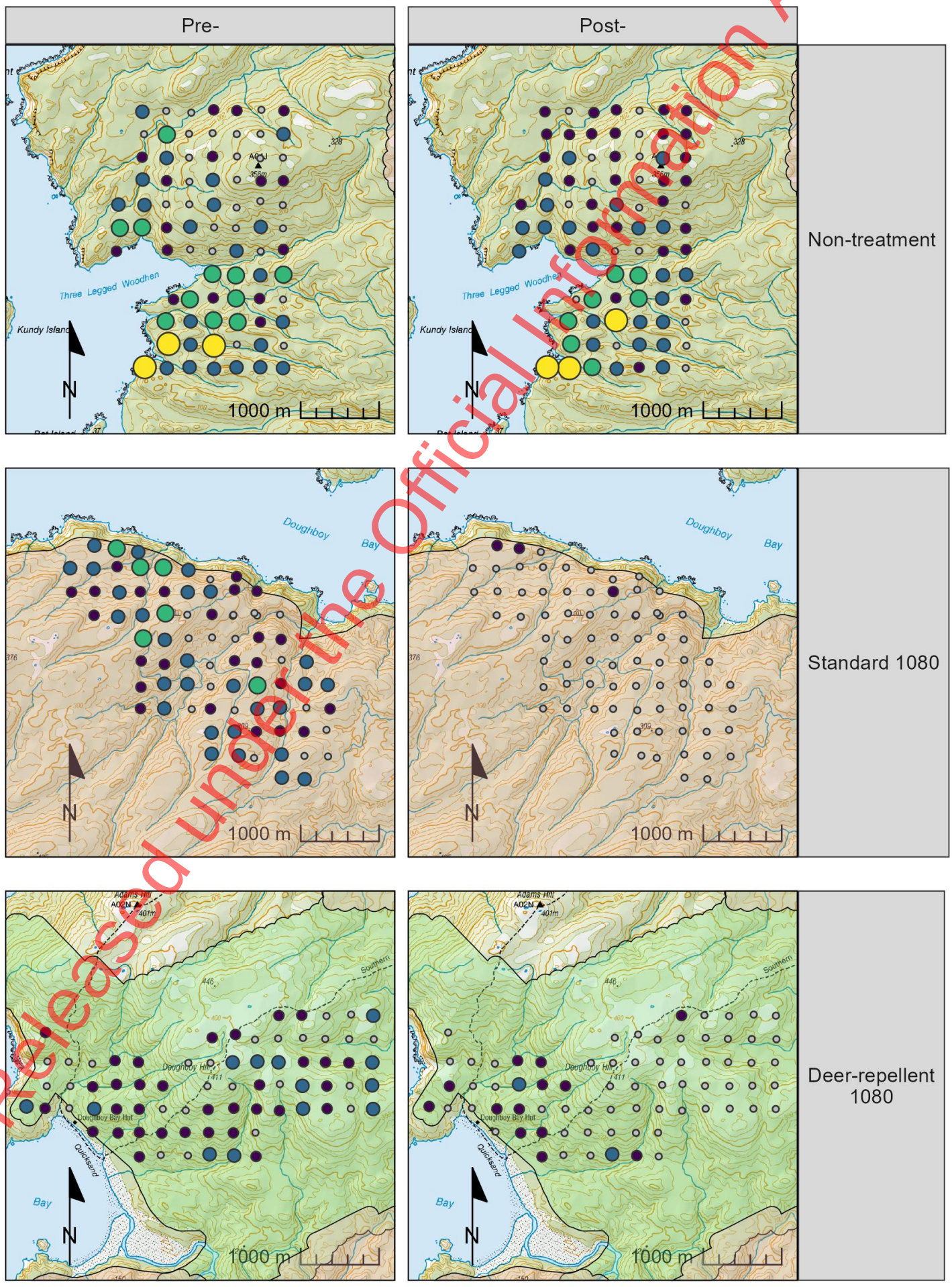
Learn more about Predator Free Rakiura: www.predatorfreerakiura.org.nz/

Get Rakiura hunting updates:

www.doc.govt.nz/parks-and-recreation/things-to-do/hunting/where-to-hunt/southland/stewart-island-rakiura-hunting/

Trail camera image of a Rakiura white-tailed deer

Maps showing the trail camera monitoring results for white-tailed deer before and after the operation



Monitoring results update #2
Pukunui predator control/suppression

25/11/25

Monitoring results for rats and a second round for feral cats, kiwi and possums are available following the aerial predator control operation on Rakiura/Stewart Island in August to protect pukunui/Southern NZ dotterel.

Rats reduced to very low levels

Rats were monitored for six weeks after the pukunui predator control operation with a network of 135 trail cameras. The results show rats were reduced to very low levels (see the maps on the next page).

This is in stark contrast to monitoring results from outside the operational area where 1080 bait was not applied and rat numbers have remained very high.

By controlling rats, we were able to target the primary target - feral cats - through secondary poisoning as they ate the poisoned rats.

The results from the Predator Free Rakiura eradication trial are separate to this and will be available soon.

Feral cat monitoring update

We've analysed another three weeks' worth of images from cameras set up to monitor feral cats. There were no detections, making it at least six weeks post-operation without feral cats.

This gives us further confidence that pukunui have the best possible chance at a successful breeding season this year. However, it's only a matter of time before feral cats reinvade. We've caught two feral cats in traps so far. One was about 500 metres from the operational boundary and the other was about five kilometres inside.

Our cameras will remain active to monitor the reinvasion and see how long it takes for feral cats to reach the Tin Range pukunui breeding grounds. This will help to inform future predator control efforts to protect pukunui.

Update on kiwi and possums

We also have another three weeks (six weeks in total) of monitoring data for possums and Rakiura kiwi.

Possum numbers have remained very low, with detections in two spots, which is likely to be two individuals. Kiwi numbers have remained high, with no discernible change before or after the operation.

One of the first pukunui chicks to hatch this season.
Photo: s9(2)(g)(ii) DOC

Update on pukunui nest surveying

The first pukunui chicks of the breeding season have hatched on Rakiura. In the latest update, the Pukunui Recovery Team have found approximately 62 eggs (47 of which are in the operational area), 22 nests, and 12 chicks. Nest surveying will continue until the end of December.

It's a promising count so far and potentially a big boost for pukunui recovery efforts. However, there's no guarantee all the eggs will hatch or that the chicks and adults will survive. The main measure of success will be the pukunui flock count in April, and also the long-term population trends.

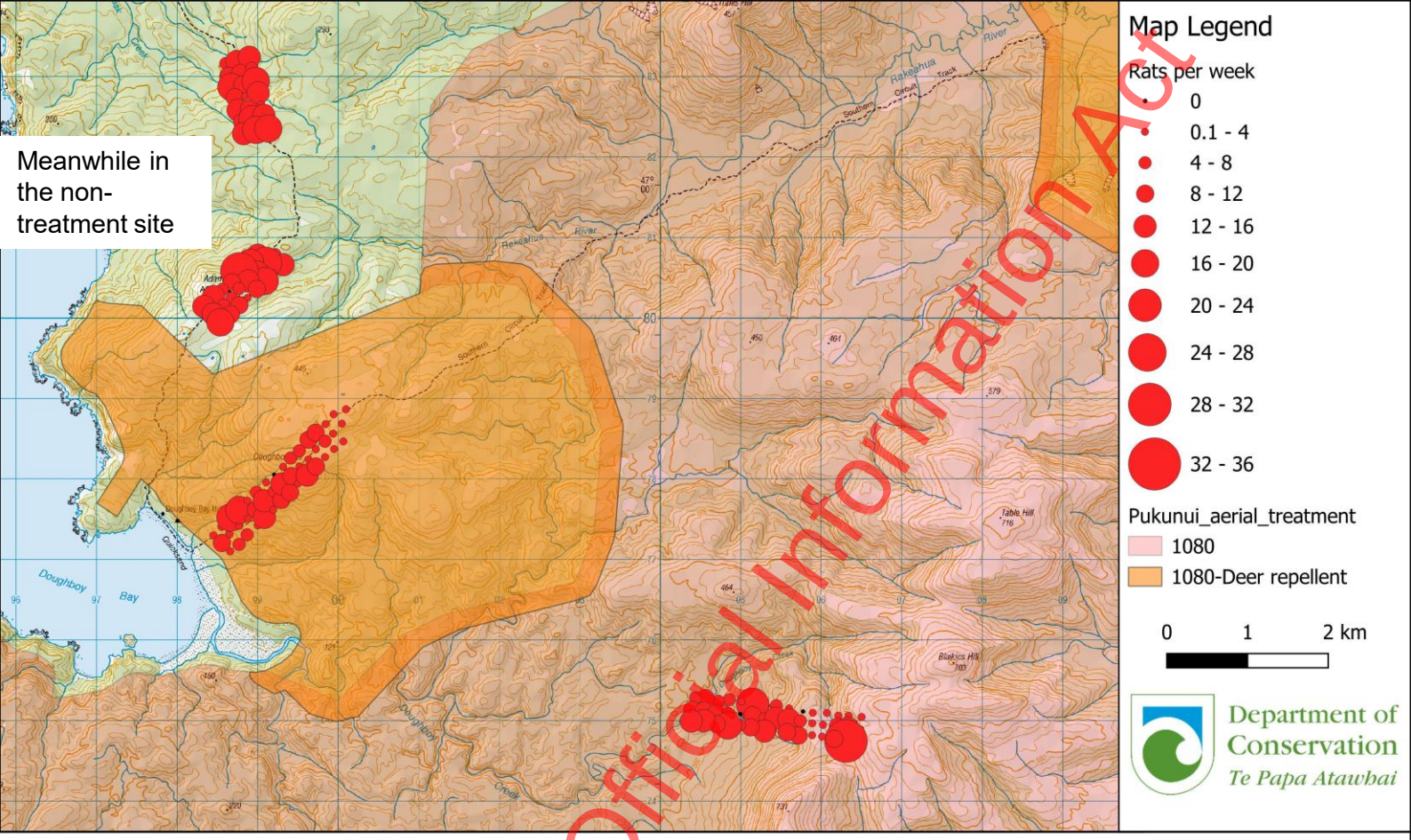
For more information

Contact DOC or ZIP Email: pukunui@doc.govt.nz

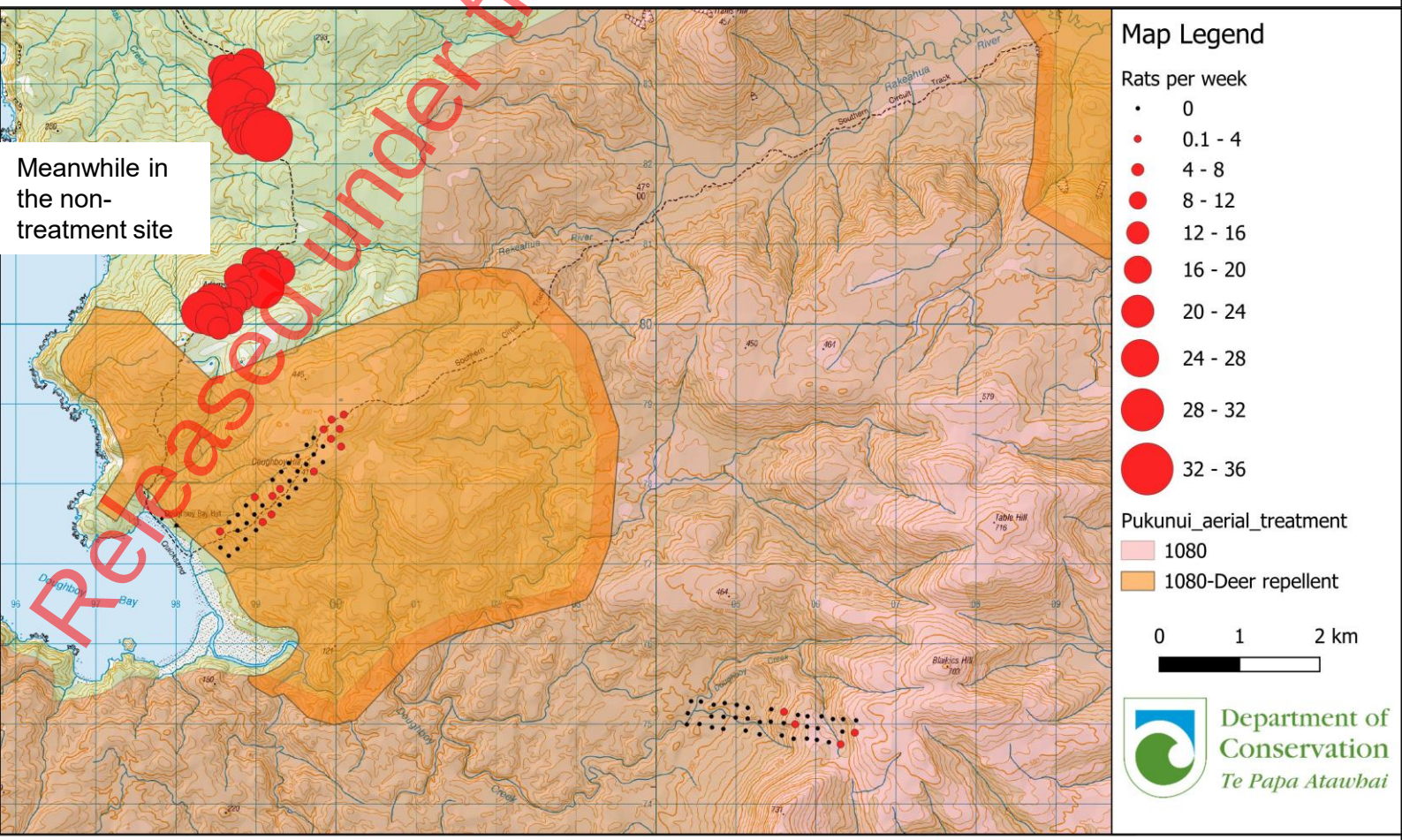
Learn more about the nest surveying work: www.doc.govt.nz/news/media-releases/2025-media-releases/pukunui-chicks-bring-hope-for-survival/

Department of Conservation
Te Papa Atawhai

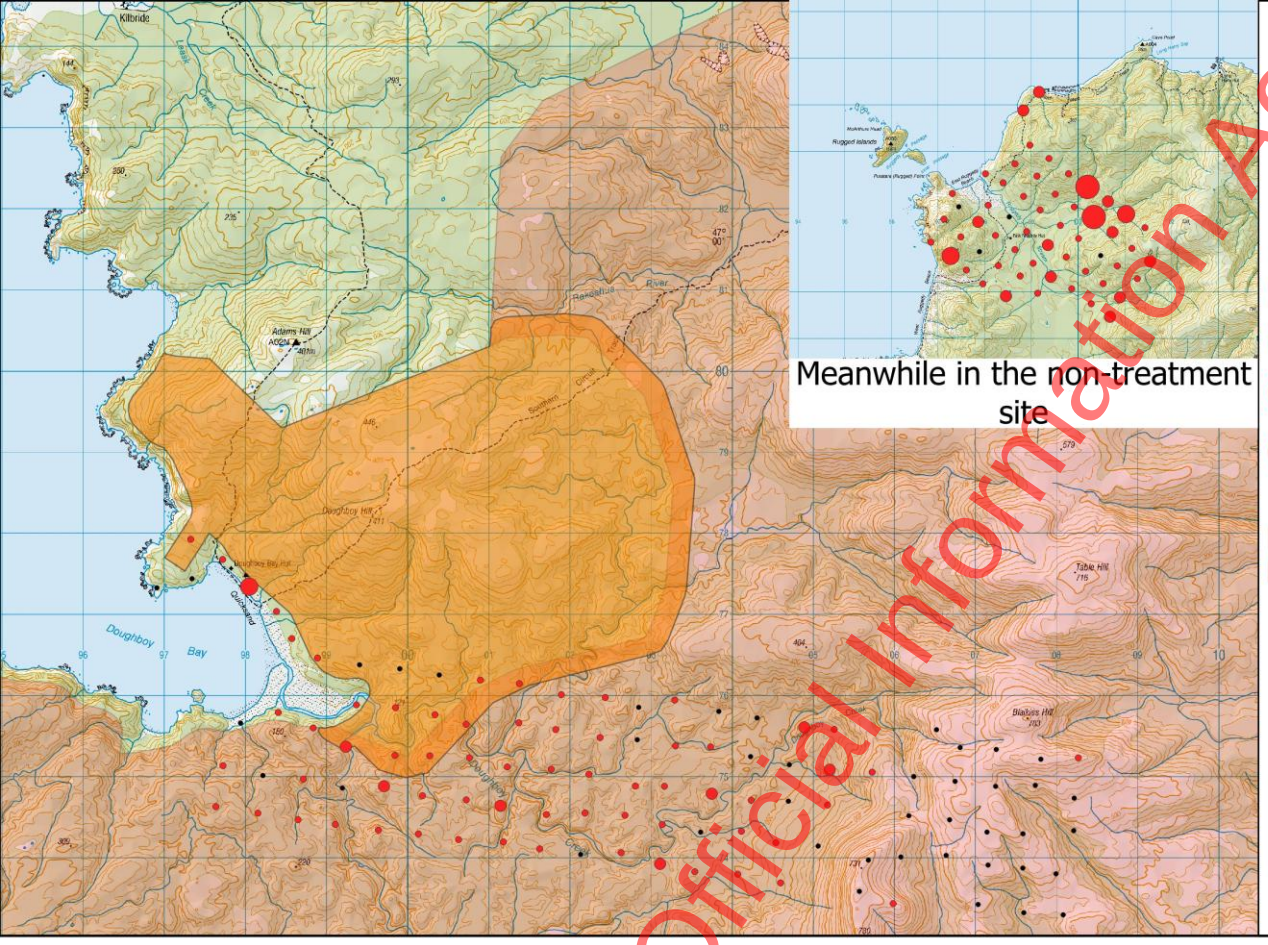
ZIP ZERO INVASIVE PREDATORS
Enabling a new future



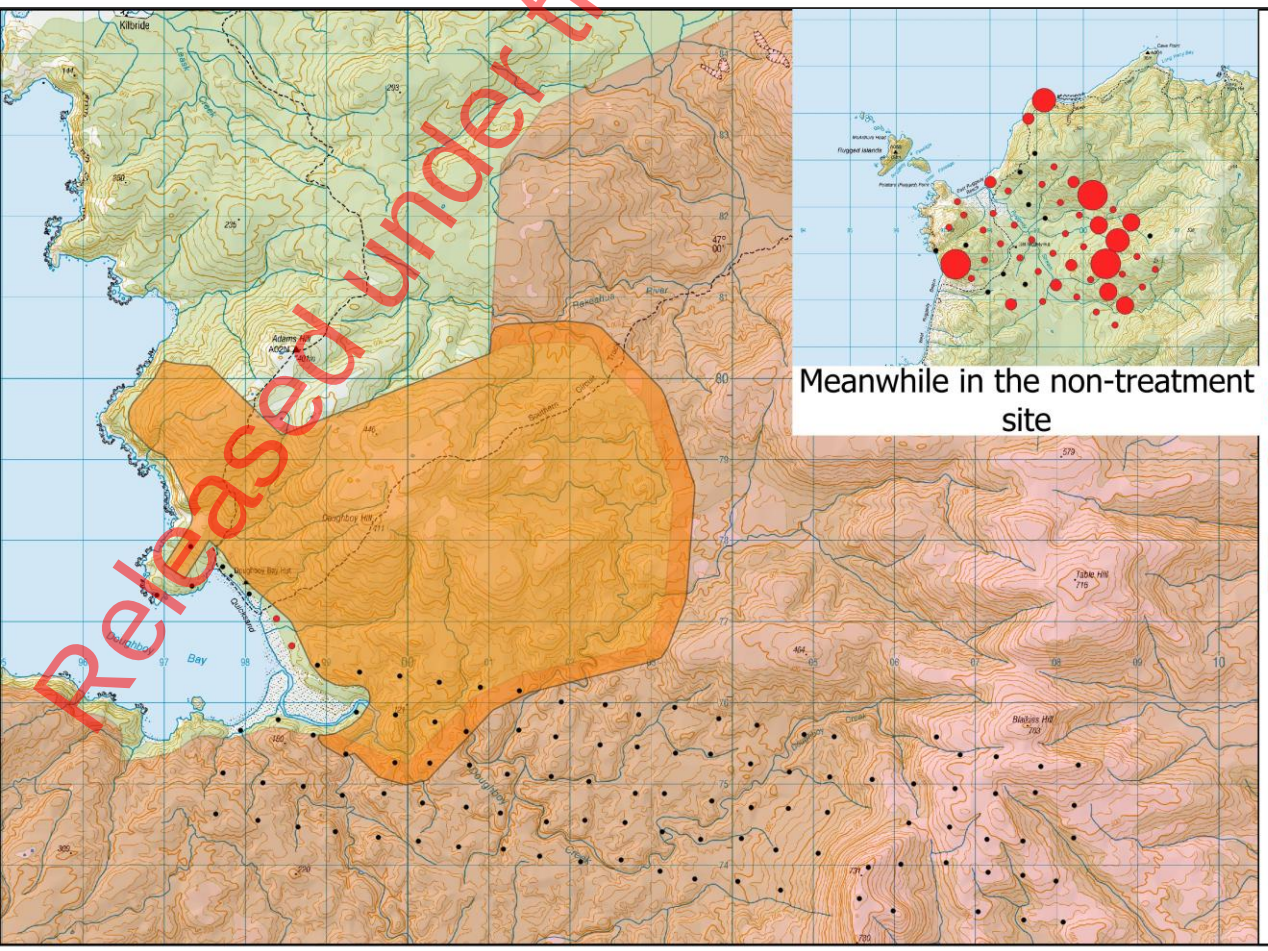
Trail camera image index for RATS on the intensive rat grids, PRIOR to the Pukunui pest control operation. These results are for the period 06/05/25 to 22/08/25



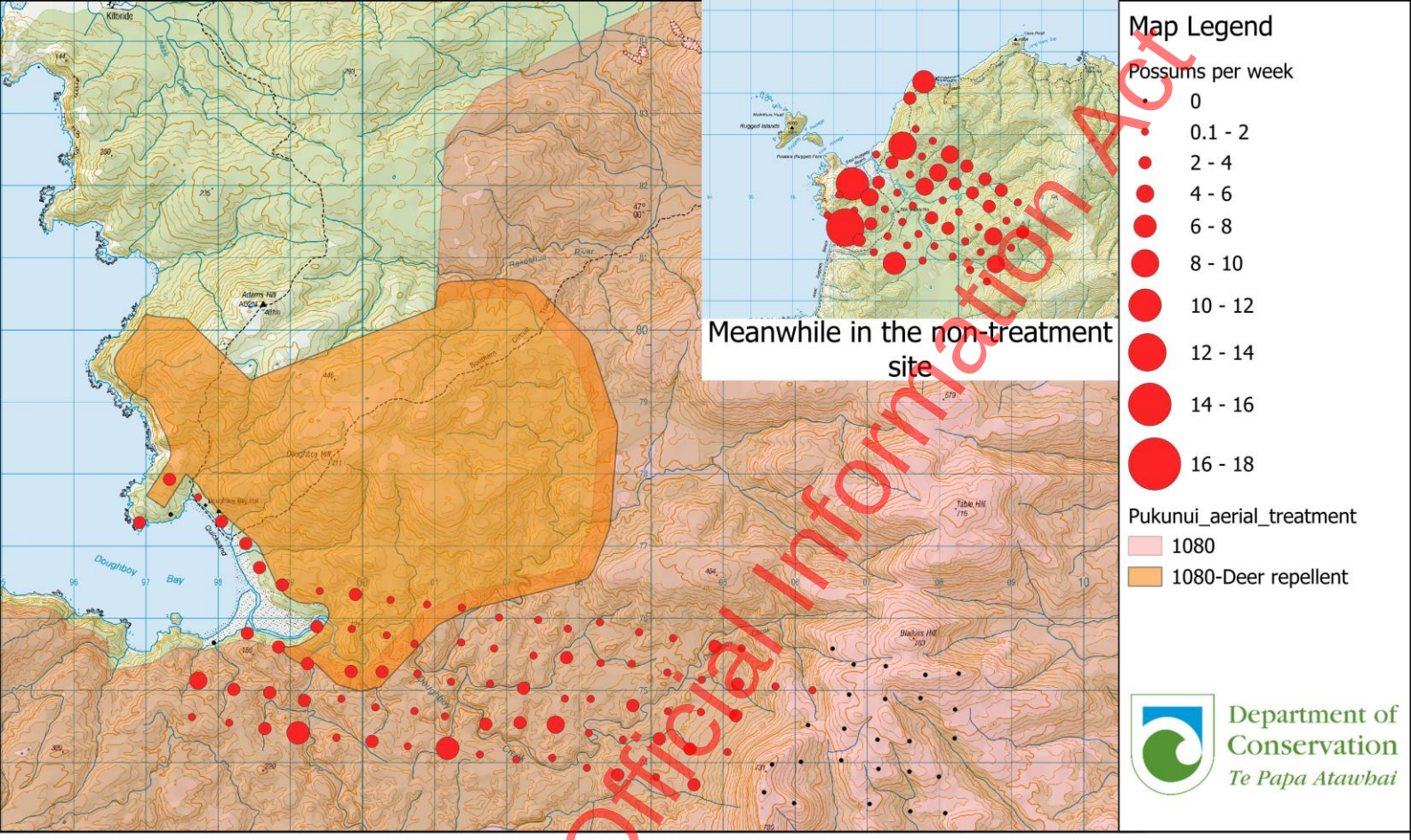
Trail camera image index for RATS on the intensive rat grids, AFTER the Pukunui pest control operation. These results are for the period 23/08/25 to 08/10/2025



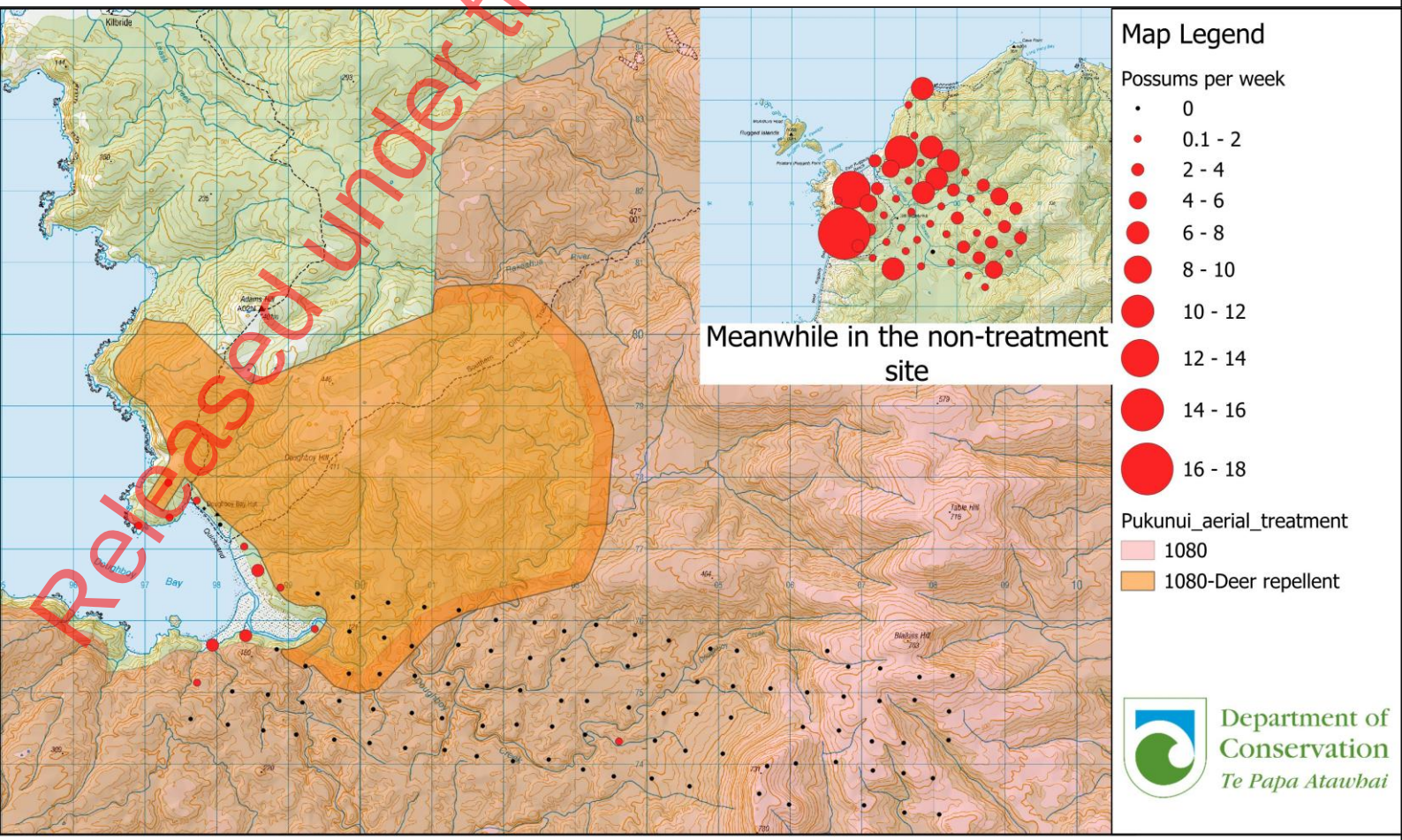
Trail camera image index for CATS on the on the cat grids, PRIOR to the Pukunui pest control operation. These results are for the period 06/05/25 to 22/08/25



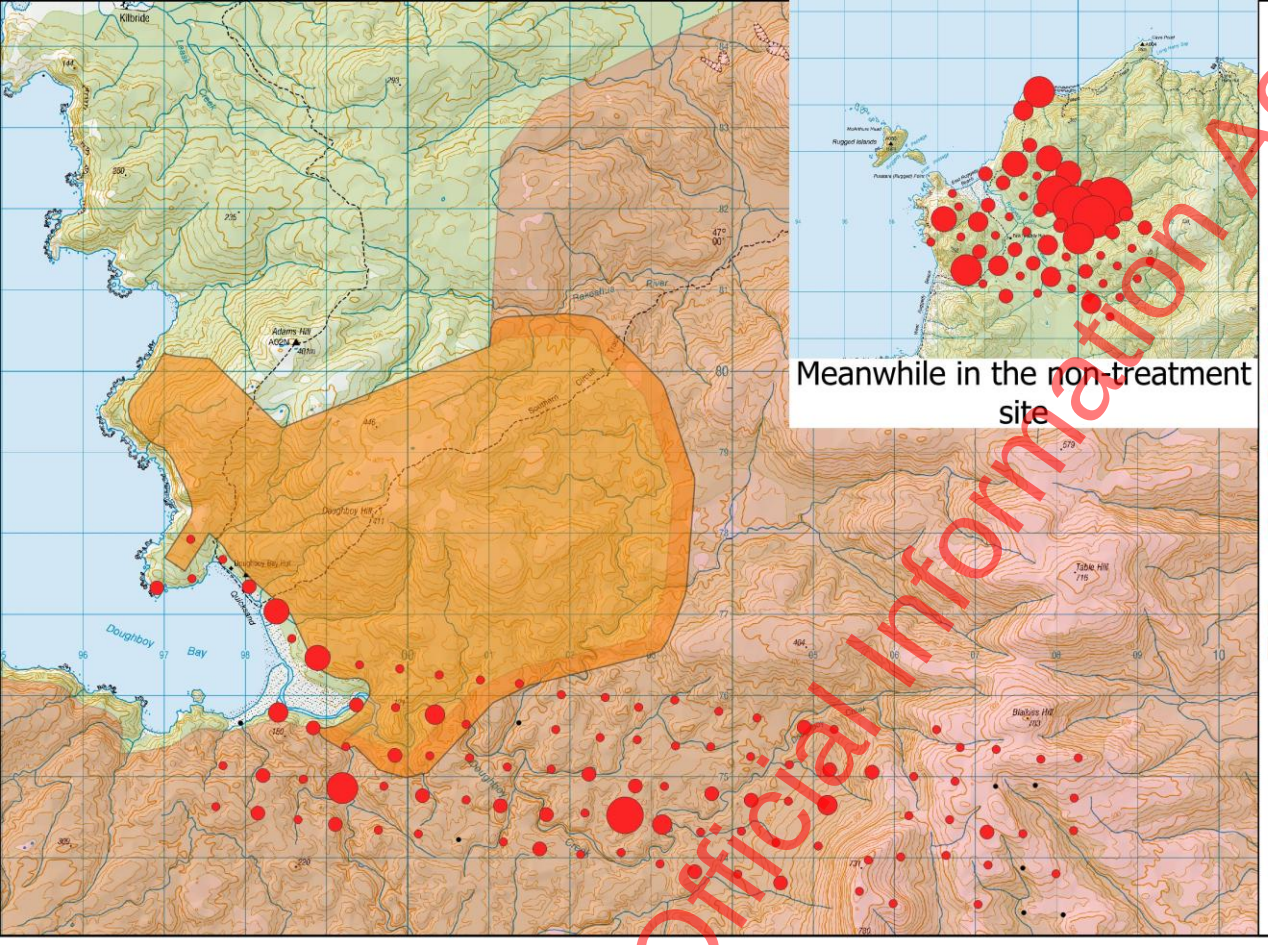
Trail camera image index for CATS on the on the cat grids, AFTER the Pukunui pest control operation. These results are for the period 23/08/25 to 08/10/25



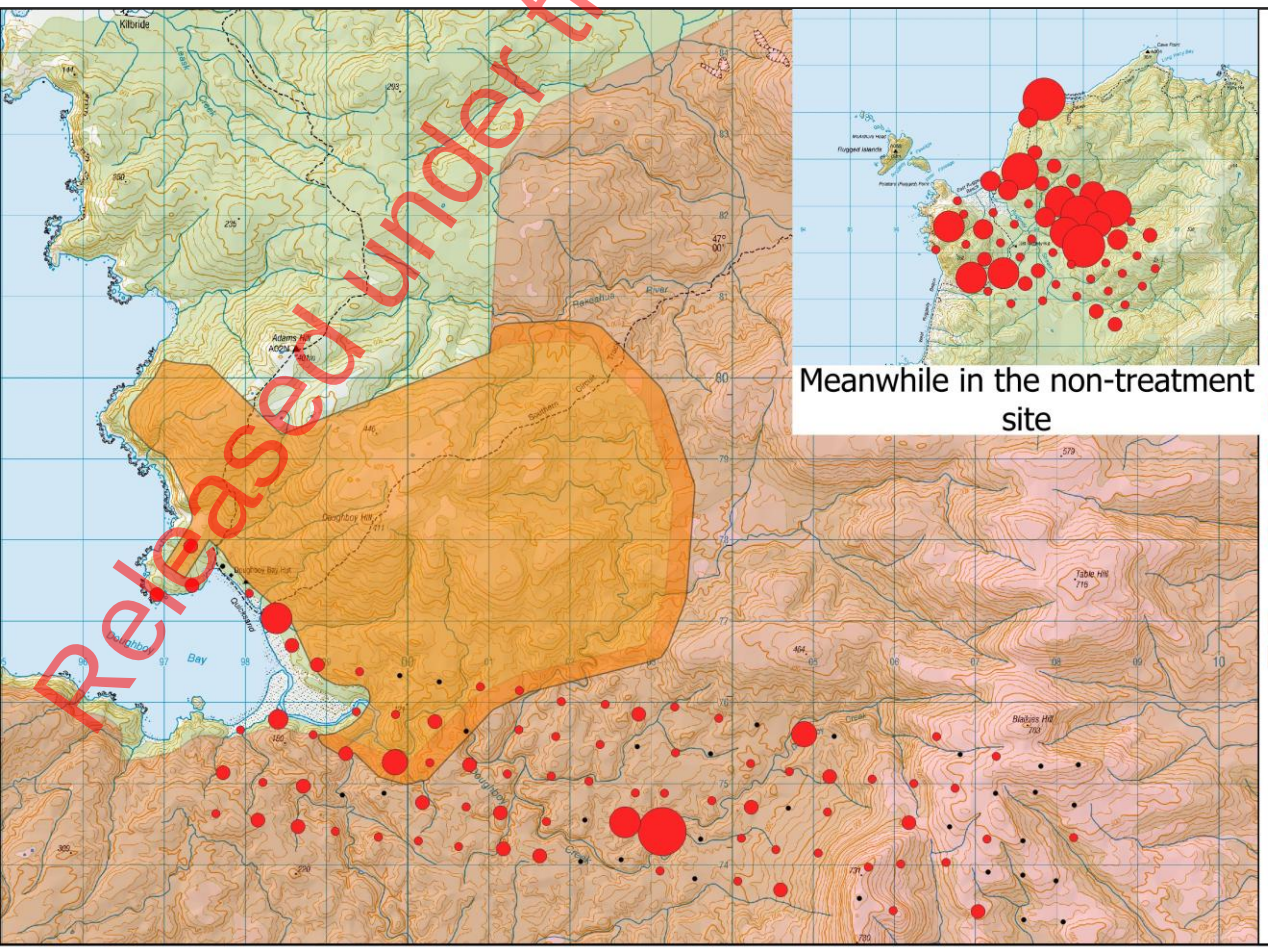
Trail camera image index for POSSUM on the on the cat grids, PRIOR to the Pukunui pest control operation. These results are for the period 06/05/25 to 22/08/25



Trail camera image index for POSSUM on the on the cat grids, AFTER the Pukunui pest control operation. These results are for the period 23/08/25 to 08/10/25



Trail camera image index for KIWI on the on the cat grids, PRIOR to the Pukunui pest control operation. These results are for the period 06/05/25 to 22/08/25



Trail camera image index for KIWI on the on the cat grids, AFTER the Pukunui pest control operation. These results are for the period 23/08/25 to 08/10/25