Department of Conservation
Te Papa Atawhai

Readymade feral cat bait research trials – Rakiura winter 2023

Operational Report

Prepared by 9(2)(g)(ii)

Version	Reason for change	Date
1	Initial draft, setting up structure	12/10/23
2	Draft complete & reviewed (JW)	04/12/23
3	Final report	20/03/24

Executive summary

To protect threatened native biodiversity, the Department of Conservation (DOC) needs to expand the toolbox for controlling and/or eradicating feral cats at landscape scale. Current tools for feral cat control have either low efficacy or are impractical to use at scale. In response to this need a readymade meat sausage feral cat bait that contains sodium fluoroacetate (0.025%) has been developed. The first hand laid field trial of the bait was successfully undertaken on Auckland Island in 2022. Further trials were needed to build an understanding of bait efficacy at reducing feral cat populations, as well as impacts to non-target species from the bait and to improve understanding of bait degradation under field conditions. The purpose of this project was to contribute to the understanding of the performance and user considerations of a novel bait product for the outcome of future registration of the bait.

The field trial was undertaken in July to August 2023 within Rakiura National Park, with the treatment area spanning 1750 ha on the north of Rakiura Stewart Island. A bait grid was established, with baits (n=600 per application) spaced approx. 60 m apart along transects that were spaced approx. 500 m apart. Around 19% of baits were monitored with trail cameras. Two applications of non-toxic prefeed bait were applied, followed by three applications of toxic bait, followed by two applications of non-toxic bait for post-toxin monitoring. To measure the efficacy of the bait on feral cat populations, we measured the change in cat activity (mean detections per 100 corrected trap nights (CTN^{-1})), the change in feral cat population density, tracked GPS-collared feral cats exposed to the bait, measured toxin residues in deceased feral cats and recorded behavioural interactions of feral cats and bait. To understand the impacts of the readymade feral cat bait on non-target species we recorded behavioural interactions of all animals and bait during the trial, radio-tracked Rakiura tokoeka (kiwi) through the trial, tested any animal carcasses recovered during the trial for toxin residue and undertook abundance monitoring for rodents and possums. To measure bait degradation during the trial we set up monitoring plots where baits were regularly sampled throughout each bait application, and rainfall and temperatures were logged.

Full analysis of data is ongoing and preliminary results are presented in this report, with detailed reporting to follow. Initial results are promising, with prefeed period cat activity measured as 6.4 (±0.8 SE) cat detections 100 CTN^{-1}, which dropped by 71% to 1.9 (±0.5 SE) cat detections 100 CTN^{-1} immediately following the toxin application. Six GPS-collared feral cats were present in the treatment area at the time of toxin application of which five died and all tested positive for sodium fluoroacetate residue. Only cats, rats and possums were observed fully consuming bait or removing it from the camera field of view. The maximum interaction of a native species with bait was a tomtit that pecked a non-toxic bait on one occasion. No tokoeka or deer were observed consuming non-toxic or toxic bait. The maximum interaction of tokoeka with bait was a bird mouthing and dropping a bait on a single occasion, while the maximum interaction for deer was sniffing the bait. Radio signals indicated that all tagged tokoeka were alive after each toxic bait application (i.e. no tags were giving mortality signals). Only two fresh carcasses/animal body parts that were not collared cats were located inside the treatment area during or immediately following the toxin applications. These were rats and both tested positive for sodium fluoroacetate residue. The concentration of sodium fluoroacetate in baits declined following exposure to rainfall, with >50% of toxin lost following at least 60 mm of rainfall.

These preliminary results indicate the bait was effective at reducing feral cat populations and likely had minimal impact on native non-target species and deer. The bait appears to degrade in the field following exposure to rainfall, similar to cereal sodium fluoroacetate baits. Once full analysis is completed, the evidence will support an application to register the bait for use in New Zealand and will help guide operational use.

Contents

Introduction

The Department of Conservation (DOC) needs to expand the toolbox for controlling and/or eradicating feral cats at landscape scale. Landscape control of feral cats is essential to protect many threatened and at-risk bird, lizard and invertebrate species, e.g., kiwi, black stilts, wrybills, NZ dotterels, Otago grand skinks and robust grasshoppers. An effective and humane bait for feral cats is also necessary for the eradication of feral cats from several of New Zealand's largest and most important islands for biodiversity such as Auckland Island, Rakiura and Chatham Islands. Feral cats have previously been removed from islands using ground-based trapping and hunting. However, the use of these techniques is challenging and carries a high risk of failure when used at scale.

On review, primary poisoning was used in 31% of island eradication operations targeting feral cats where the methods were documented[1]. On larger islands (>2000 ha), poisoning appears to be more critical due to the labour requirements of alternative tools such as trapping. This is evidenced by all successful feral cat eradications on islands larger than 2000 ha, (with the exception of Santa Catalina, (3890 ha,) and San Nicolas, (5896 ha)), having used primary poisoning for knockdown[2]. For the proposed Auckland Island (45 891 ha) eradication, 'knocking-down' or rapidly reducing the feral cat population with an island-wide application of a highly palatable toxic bait, then 'mopping-up' survivors using ground techniques (e.g. cameras, targeted ground-laid toxic bait, leghold traps) is considered to offer the highest chance of achieving eradication[3]. As such, a toxic feral cat bait that could be hand-laid or applied aerially is highly desired to facilitate the eradication of feral cats from Auckland Island.

At present, registered toxic baits for feral cats in New Zealand are extremely limited. We have no baits that are registered for aerial distribution in New Zealand. The two baits registered for feral cats are:

- 0.10% sodium fluoroacetate fishmeal-polymer pellet that can be hand laid or applied in bait stations. This bait has low efficacy[4]
- Para-aminopropiophenone PredaSTOP paste (PaPP) in mince balls that can only be applied in bait stations. Bait stations are labour intensive and inefficient to use at scale.

The behavioural variability of the target species between populations and individuals mean it is unlikely a single bait will meet all conservation objectives. In Australia both PaPP and sodium fluoroacetate meat baits are registered for feral cat control. We anticipate that if multiple bait types are registered in New Zealand, they will have their respective niches. Having both toxicants and different bait types available allows practitioners to choose the most appropriate bait for their specific problem or to alternate baits from year to year.

The purpose of this operation was to undertake a second field trial that built on lessons from an initial field efficacy trial of a ready-made feral cat encased meat sausage bait containing 4.5 mg sodium fluoroacetate that was undertaken on Auckland Island in the NZ subantarctic in 2022[5] (HSC100333). Results from this initial study showed the bait can significantly reduce feral cat populations. Further investigation of how it is applied will increase bait encounter rates, it's leverage over alternative foods and a higher level of population reduction.

1.1. Summary of key documents

Document	Link	Description
Operational plan	DOC-7229821	Delivery plan for research trial into efficacy of readymade feral cat bait, including how the work meets compliance standards. Incorporates feral cat detection, feral cat toxic bait trials, trapping and GPS collaring and possum and rat abundance indices.
Operational report	DOC-7514749	This document. Outlines methods, results, logistical details and preliminary findings from the bait trial investigations.
Project register	DOC-7041141	The one stop shop for all things project management: work plan, resourcing, document register, task list, costing, issues & risk register and decision log.
Communication plan	DOC-7054703	Plan for and log of communications for the project, including identified stakeholders and planned and actual communications & outcomes.
Project factsheet	DOC-7078391	High level, plain language fact sheet about the project that has been circulated with partners and stakeholders.
Compliance register	DOC-7350705	Register of conditions and performance standards to be met by the project.
Health & safety procedures	H&S Plan DOC-7293926 Emergency Response Plan DOC-7364821 Risk Manager Plans ID24654 & ID6490	Presents safe working practices and protocols and appendices the communications details for daily scheds.

1.2. Site description

Rakiura Stewart Island is New Zealand's third largest Island (174 800 ha) and is ca. 30km south of the South Island. Around 85% of the island is National Park. The climate is temperate, characterised by predominantly westerly winds and frequent rainfall. The treatment area is within the national park, on the north coast of Rakiura Stewart Island between Lucky Beach and Murray River. The vegetation mainly consists of mature broad-leafed-conifer forest, rising to montane scrub. Pest species within the site included feral cats (*Felis catus*), possums (*Trichosurus vulpecula*), white-tailed deer (*Odocoileus virginianus*), rats (*Rattus* spp.). Pest control in the area has been limited; the last work was hand-laid toxin for possum control over 5 years ago. No rodent or cat control occurs in the area.

The site can be accessed by the public for recreation and the Northwest Circuit tramping track passes through the treatment site. Access is via backcountry walking track (2 – 3 days) or marine vessel. There are two huts in the treatment area – the Christmas Village trampers hut and the Christmas Village hunters hut (latter must be booked). There are three hunting blocks within the

treatment area – Lucky, Christmas and Rollers blocks. The timing of the trial (Jul – Aug) was outside of the main visitation period, and there were very few trampers on the Northwest Circuit at this time. The hunting blocks were closed during the operation. An exclusion buffer of 25 m was applied to public tracks and of 50 m applied to structures. The entire treatment area and boundary was within Rakiura National Park.

The Treaty Partner for Rakiura is Ngāi Tahu. Four local hapu (Hokonui Rūnanga, Te Rūnaka O Awarua, Oraka/Aparima Rūnaka and Waihopai Rūnaka) jointly manage relationships between DOC and tangata whenua.

2. Research objectives

The purpose of the project is to contribute to the understanding of the performance and user considerations of a novel bait product for the outcome of future registration of the bait. The information gathered will contribute to the data package required for registration. Alternatively, if performance expectations are not met the study will inform amendments to the product or project review. The primary objectives of this trial are to:

a) Test the efficacy of a novel readymade feral cat bait;
b) Understand the impacts of novel readymade feral cat bait on non-target species;
c) Improve understanding of bait degradation in the field

There are no site-specific biodiversity outcomes for this project.

Result target

The result targets will be:

- A reduction of feral cat population of >80% in treatment area during toxin trial and these deaths are likely attributable to the readymade feral cat bait.

As data analysis is currently underway, result targets are out of scope of this document.

Outcome target

The outcome target of this operation is:

- To provide data and reporting on the efficacy of the readymade feral cat bait and risks of the bait to non-target species by end of 2023/24 financial year.

As data analysis is currently underway, outcome targets are out of scope of this document.

2.1. Test the efficacy of a hand laid novel readymade feral cat bait on feral cats

The pesticide used was readymade feral cat bait: 4.5 mg sodium fluoroacetate in encased 18 g rabbit meat sausage (0.025%).

To test the efficacy of the hand laid readymade feral cat bait, a 'soft grid' of baits was established throughout the single treatment area (1725 ha). Each treatment was 600 baits (0.35 baits ha^{-1}). Baiting lines and bait points were marked. Abundance indices of non-target species (possums and rodents) were collected to understand the impact of these species on bait availability.

To estimate the cat population density before and after treatment, and to establish how many individuals are in the area, as well as record how target and non-target species interact with bait, a 240 x 500 m 'soft grid' of cameras was established at 19% of bait sites. Fourteen feral cats were trapped within the proposed treatment area several months prior to baiting and were fitted with GPS collars. GPS data from the collars showed how much time cats spent inside the treatment area during the bait trial. VHF signals provided an indication of mortality and allowed us to track in on cats

died during the bait trial to retrieve tissue samples. Fresh carcasses of any deceased animal found inside the treatment area during toxin application were collected for toxin residue testing.

Methods

Bait efficacy

Baiting

The pesticide used was hand laid readymade feral cat bait: 4.5 mg sodium fluoroacetate in sheep intestine encased 18 g rabbit meat sausage (0.025%) dyed green. Non-toxic baits for prefeed and post-toxin monitoring were undyed 18 g rabbit meat sausage encased in sheep intestine.

A marked baiting grid was established where baits were placed on open ground every 60 m (±12 m; range = 48 – 72 m) within 100 m either side of pre-determined transects lines, which were spaced 500 m apart (Figure 2). Initially 625 bait points were laid, but this was reduced to 600 after the second pre-feed application to allow three rounds of toxic baiting, rather than two rounds of 900 baits as initially planned. Accounting for a 250 m buffer from bait points, the total treatment area was 1725 ha, equating to 0.35 baits ha^{-1}. Where possible, baiting lines followed habitat features where cats were more likely to travel and baits were placed along or adjacent to features cats are more likely to encounter them, e.g. game trails, habitat boundaries, etc. Bait sites and baiting lines were flagged to increase efficiency when servicing the grid. Bait was placed at least 25 m from a public track, and 50 m from a hut.

There were seven applications of bait: two rounds of non-toxic prefeed approximately 10 days apart, followed by three rounds of toxic bait approximately 7 days apart, followed by two rounds of non-toxic bait for post-toxin monitoring also approximately 10 days apart (Table 1). Toxic baiting dates were adjusted so that baiting occurred in the most suitable weather window, while non-toxic baiting was less constrained by weather conditions. Suitable weather was considered a forecast of <30 mm cumulative rainfall over the 3 – 4 days following toxic bait application. The status of all bait was recorded after each baiting round. Uneaten bait was removed after each application and disposed of.

Following baiting, two carcass monitoring plots were established in broad representative habitats from the treatment area (coastal forest and approx. 300 m asl) to inform the caution period (Figure 1; Figure 2). Each plot consisted of a large mesh cage which contained a possum carcass and a smaller mesh cage that held 5 non-toxic baits. The smaller mesh cage excludes rodents.

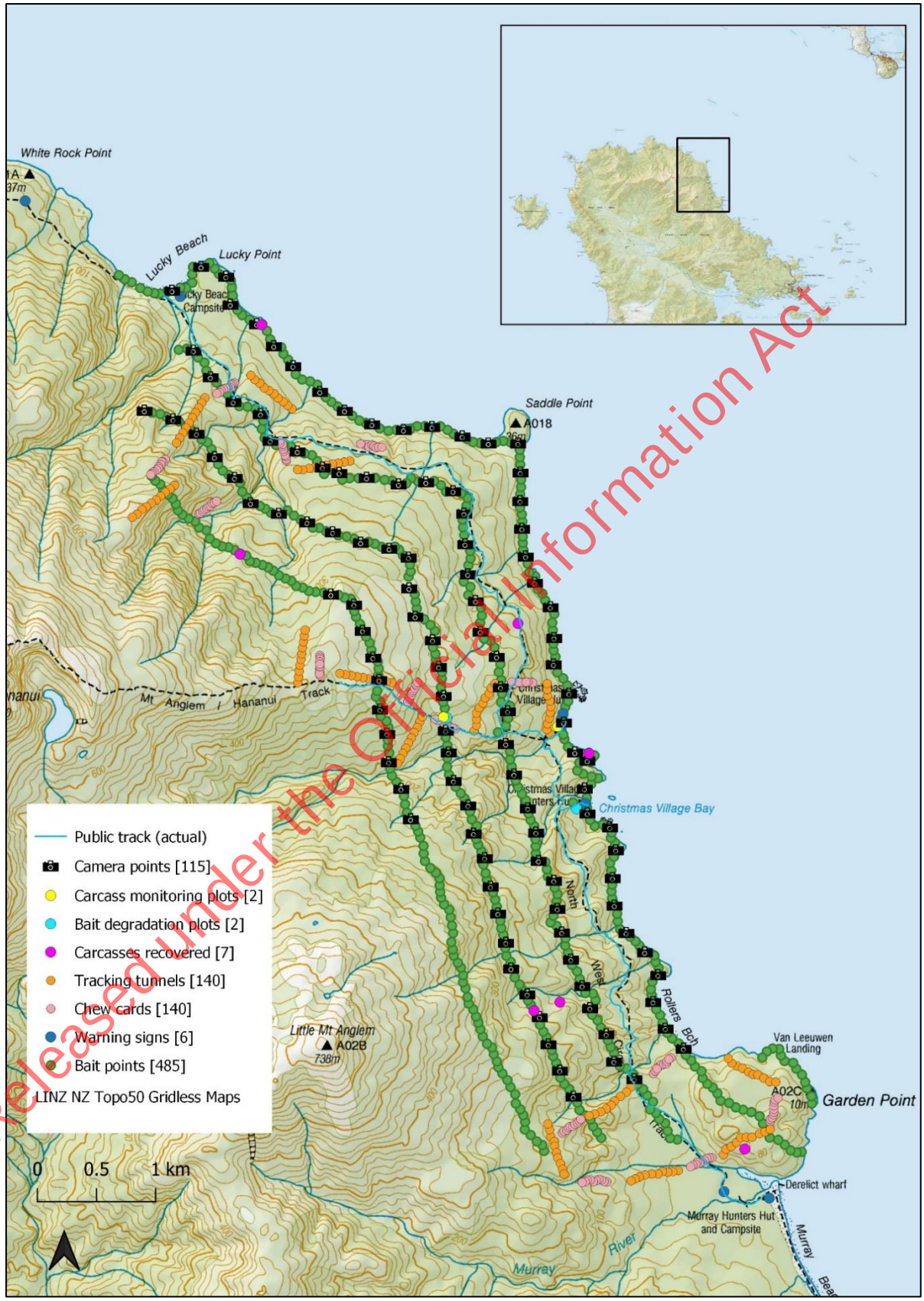
A task spec for bait grid establishment can be found at DOC-7378800 and for servicing can be found at DOC-7378904.

More information on the set up of the bait grid can be found in the trip report: DOC-7390821.

Table 1. Baiting applications during the field trial of readymade feral cat bait on Rakiura in winter 2023

Bait application	Bait type	Baiting/servicing dates	Mean bait period (nights)
Prefeed 1	Non-toxic	02-05/07/2023	14
Prefeed 2	Non-toxic	14-17/07/2023	7
Toxin 1	Toxic	22-24/07/2023	6
Toxin 2	Toxic	28-30/07/2023	8
Toxin 3	Toxic	05-07/08/2023	7
Post toxin 1	Non-toxic	12-14/08/2023	10
Post toxin 2	Non-toxic	22-26/08/2023	12
Bait grid removal	NA	01-04/09/2023	NA

1. Start point: possum carcass and five non toxic sausage baits inside mesh cages at coastal site (top) and 300 m asl (bottom) to inform caution period for the readymade feral bait trial on Rakiura in 2023. Note mesh cages were fitted over both baits and possums at both carcass monitoring sites, as seen in top photo.



2. Study design and features of the readymade feral cat bait trial on Rakiura in July – August 2023, including the camera grid (bait at each camera point), bait grid, non target species monitoring devices, bait and carcass degradation plots, warning signs and location of carcasses retrieved during the trial (n = 5 feral cats; n = 2 rats)

Cat collars

Three and a half months prior to baiting, fourteen feral cats were captured by live-capture ground-set Victor 1.5 soft-jaw traps from inside the proposed treatment area. Traps (n = 88) were baited with barracouta pieces and were hazed to reduce the risk of capturing kiwi. Traps were set approximately every 250 m and were placed adjacent to habitat features where cats were more likely to pass e.g. game trails. Most traps were placed along or within 20 m of the coast (n = 52), and the rest were placed in forest habitat (n = 36).

If captured cats weighed ≥1.2 kg they were fitted with a Litetrack 60 RF GPS collar weighing 60 g, set to record their location every 1.5 hours and transmit VHF from 07:00 – 19:00 h NZDST. All black cats that were captured had a unique pattern bleached into their fur to allow easier recognition in camera footage during the bait trial. All cats captured were photographed to assist with identification in camera footage during the bait trial.

During the toxic baiting period collared cats were tracked using VHF. Staff mainly tracked from the ground, but three short tracking flights from the helicopter were also undertaken. If their signals were in mortality mode, staff tracked into the cat and retrieved the collar and tissue samples if the cat was freshly dead, or just the collar if the cat had died before the bait trial commenced (i.e. was in a significant state of decay). Using the Pinpoint Host platform, GPS data were extracted from the collars to understand how much time cats spent inside the treatment area/were exposed to toxin. GPS data were downloaded remotely via VHF from one cat that was outside the treatment area during toxic baiting but subsequently moved back into the area.

A task spec for leg-hold trapping can be found at DOC-7295637. A task spec for cat collaring and bleaching can be found at DOC-7295637. A task spec for tracking collared cats can be found at DOC-7449080.

A trip report that details more about method for the cat collaring can be found at DOC-7312401.

Cameras

Trail cameras were established in the core of the treatment area, monitoring approximately 19% of baits (n=115 cameras; 240x500 m grid; Figure 2). Cameras were fixed approximately 30 cm off the ground, with the field of view centred on the bait, which was 2.5 – 3.5 m away. Cameras were set to record videos and recorded throughout all baiting phases. SD cards were changed during every rebaiting. Footage was classified before the next bait application using a custom-built classifying interface. All footage with animals was classified (including species; bait present/absent; interaction ignore/sniff/mouth & drop/partial consumption/full consumption).

Several measures are being used to understand the efficacy of the bait for feral cat control, most of which utilise a before-after design:

- Change in cat activity (mean detections per 100 CTN^{-1})
- Change in cat population density
- Timing of the first and last detections of individual cats relative to toxic bait application
- Toxin residue levels of deceased cats and time of death relative to toxin application
- Behavioural inferences from cat interactions with bait

Cats were identified to individual level by one observer who manually reviewed each video (Figure 3). For spatially explicit occupancy modelling, multiple videos of an individual cat recorded by the same camera on the same day were treated as a single detection, unless the cat was recorded on another camera before returning to the first one. For cat activity, multiple videos of an individual cat recorded by the same camera on the same day were treated as a single detection if they occurred within 30 min of the previous video of the same cat, unless a cat was recorded on another camera before coming back to the first.

If bait was present when a cat (or any animal) was detected, their maximum interaction in each video was scored as: ignore, sniff, mouth/drop, partial consumption, full consumption or remove bait from frame. For each encounter (as defined above), the maximum interaction type was recorded.

A task spec for camera grid establishment can be found at DOC-7378800 and for servicing can be found at DOC-7378904. A task spec for camera data management can be found at DOC-7379464.

3. Example of GPS collared feral cat from trail camera footage captured during readymade feral cat bait trial on Rakiura during July August 2023. The bait can be seen in the centre of the mark, marked by a popsicle stick.

Carcass residues

Approximately 50 g of skeletal muscle and the whole stomachs were retrieved from any animals found deceased inside the treatment area during or immediately following the toxic baiting period. Skeletal muscle was sent to the Toxicology Laboratory at Manaaki Whenua to test for toxin residue. Whole stomachs were visually inspected for bait and were only supplied for residue testing if skeletal muscle was inconclusive.

A task spec for retrieving tissue samples from freshly deceased animals can be found at DOC-7449080.

Results

Bait efficacy

Statistical analyses are currently underway, and preliminary results are presented where available.

Cat collars

Of the 14 cats collared, only 7 were alive/detected during the bait trial. Six cats died before the trial began (mean = 8 weeks before pre-feed baiting began; range 1 – 13 weeks before pre-feed baiting began)., and one cat remained unaccounted for – it was not detected on camera or via VHF tracking. Of the remaining collared cats, 6 were present inside the treatment area during the toxic baiting period. One additional collared cat was known to be alive, but outside the treatment area at the time of toxic baiting. Utilising the mortality signal from the collars, fresh carcasses of five of six collared cats present during toxic baiting were retrieved (Figure 2). The sixth collared cat that was present inside the treatment area during baiting was observed again during the post-toxin monitoring period. The collared cat that was outside the treatment area during toxic baiting moved back into the

treatment area during the post-toxin monitoring period. Collars were retrieved from six cats that died before the trial began, with both the mortality data and condition of the carcasses confirming that the cats had died in well advance of the bait trial.

Preliminary analysis of cat tracks shows that most cats stayed <100 m asl and cats ranged up to 15 km from their capture point.

Collared cat and cat trapping data can be found at DOC-7305392.

GPS data from collared cats can be found in the NET Q: folder.

Cameras

A minimum of 46 individual cats were identified from 155 detections from camera footage (41 tabby cats and 5 black cats). There were a further 85 detections of cats that could only be identified to coat colour (black or tabby) because footage quality was too poor to assign an ID.

Of the 46 cats that were individually identifiable, 31 were first detected before toxic baiting and only 2 of these were detected again after the toxic baiting period. Nine cats were first detected during the toxic baiting period and 4 of these were detected again after the toxic baiting period. Only 5 cats were detected for the first time after the toxic baiting period, and all of these cats were only detected once. This shows cat detections slowed following the toxin application (Figure 5).

During the prefeed period cat activity was measured as 6.4 (±0.8 SE) cat detections 100 CTN^{-1}. Immediately following the toxin application cat activity was measured as 1.9 (±0.5 SE) cat detections 100 CTN^{-1}, a reduction of 71% (Figure 4).

Cameras were monitoring approximately 19% of baits. Cats were observed encountering bait on 84 occasions: 56 times when non-toxic bait was present and 28 times when toxic bait was present. Regardless of whether the bait was toxic or non-toxic, cats were more likely to ignore bait than interact with it (Table 2). Given the reduction in cat activity and detections following the toxic bait application it would appear that the bait was palatable to the majority of cats, despite what the bait encounter data suggests.

Master camera occupancy data can be found at DOC-7514586.

Cat detection master data can be found at DOC-7508833.

Bait interaction master data can be found at DOC-7514590.

Example footage of cats interacting with bait can be found here.

Table 2. Maximum interaction of feral cats with each bait per encounter event by bait type as captured on trail camera during readymade feral cat bait trial on Rakiura in winter 2023

Behaviour / Bait type	Non-toxic bait (n = 456)	Toxic bait (n = 342)
Ignore	24	18
Sniff	22	7
Mouth and drop	2	1
Partially consume	5	2
Fully consume	3	0
Total encounters	56	28

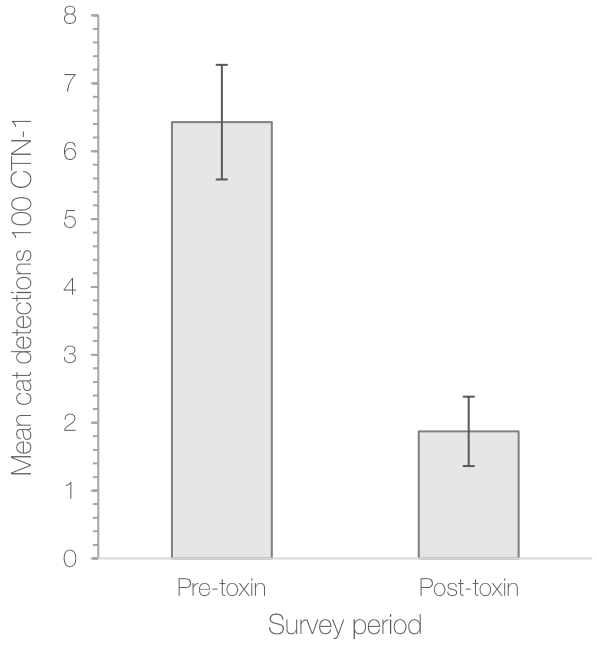


Figure 4. Mean cat detections ± SE per 100 corrected trap nights (100 CTN^{-1}) within the treatment area immediately before and after the application of readymade feral cat bait

5 First and last detections of individual cats (each row is an individual cat) during readymade feral cat bait trial on Rakiura in Jul-Aug 2023. The shaded red area indicates the period when toxic bait was available (three applications approximately 7 days apart).

Carcass residues

The radio frequency of 5 collared cats entered mortality mode during the toxic bait applications and five carcasses were located. Most carcasses were located in dens or under vegetation (Figure 6). All 5 fresh cat carcasses collected during the toxic baiting period tested positive for sodium fluoroacetate residue (Table 3). None of the stomachs of the deceased cats still contained bait. Piles of vomit that contained bait were found close to some cat carcasses (Figure 6).

Carcass monitoring was undertaken approx. 4.5 months following bait application (12 January 2024). All baits and carcasses were completely broken down and the caution period was ended (Figure 7). Approximately 630 mm rain fell in Oban between Aug – December 2023. Warning signs were removed following the January check, and the status updated on the Pesticide App.

Toxin and residue assay results can be found at DOC-7274324.

Table 3. Concentration of fluoroacetate (µg/g) found in skeletal muscle of cats found deceased inside the treatment area following application of readymade feral cat bait containing sodium fluoroacetate. Minimum detectable level of fluoroacetate was 0.001 µg g^{-1}.

Cat ID	Sample ID	Carcass weight (kg)	Sodium fluoroacetate concentration (µg g^{-1})
34112	Cat_27_muscle	2.80	0.47
34116	Cat_40_muscle	3.00	0.44
34106	Cat_08_muscle	Unknown	0.05
34118	Cat_46_muscle	Unknown	0.67
34108	Cat_15_muscle	2.49	0.73

Figure 6. Arrow point to deceased GPS VHF collared feral cat in den located during the readymade feral cat bait trial on Rakiura in winter 2023. Circled is two piles of vomit containing the green toxic bait located nearby.

7. End point: carcass monitoring plots at the coastal site (top) and 300 m asl (bottom) on January 12, 4.5 months following bait application during the readymade feral cat bait trial on Rakiura in winter 2023.

2.2. Understand the impacts of novel readymade feral cat bait on non-target species

Methods

Kiwi tags

Fifteen sub-adult and adult Rakiura tokoeka (*Apteryx australis australis*) were captured inside the proposed treatment area prior to the bait application, in early May 2023. Birds were fitted with RF

transmitters on leg bands, which were set to provide 24 hour radio signal and would change the frequency of pulses if the bird was immobile for >24 hours.

Tokoeka were tracked following each toxic baiting round, to confirm mortality status. The bearing, signal strength and signalling location were recorded, along with the status of the bird. Tags were removed from tokoeka in the summer following the bait trial (January 2024).

A task spec for tokoeka tagging can be found at DOC-7321091.

Bait interactions

As for cats, if bait was present when an animal was detected, their maximum interaction in each video was scored as: ignore, sniff, mouth/drop, partial consumption, full consumption or remove bait from frame. For each encounter, the maximum interaction type was recorded.

Possum monitoring

Abundance monitoring of possums was undertaken to provide a measure of how possum abundance impacts bait availability and to ascertain whether the bait impacted possum abundance. Following standardised design[6], fourteen chew card transects (n=10 cards per line; aniseed paste) were established inside or very close to the treatment area and were run for 3 nights during the prefeed phase and after toxic baiting during the post-toxin monitoring phase.

A task spec for setting up and running the chew cards can be found at DOC-7391796.

Rodent monitoring

Abundance monitoring of rodents was undertaken to provide a measure of how rodent abundance impacts bait availability. Following standardised design[7], fourteen tracking tunnel transects (n=10 cards per line; peanut butter lure) were established inside the proposed treatment area and were run for one night during the prefeed period, approximately 1 week before toxic baiting. No monitoring was undertaken following toxic baiting. Tunnels were installed approximately 10 weeks before use to allow tunnels to 'weather in'.

A task spec for tracking tunnel installation can be found at DOC-7321242 and a task spec for running the tracking tunnels can be found at DOC-7391796.

Carcass residues

Approximately 50 g of skeletal muscle and the whole stomachs were retrieved from any animals found deceased inside the treatment area during or immediately following the toxic baiting period. Skeletal muscle was sent to the Toxicology Laboratory at Manaaki Whenua to test for toxin residue. Whole stomachs were visually inspected for bait and were only supplied for residue testing if skeletal muscle was inconclusive.

A task spec for retrieving tissue samples from freshly deceased animals can be found at DOC-7449080.

Results

Tokoeka tags

Radio signals indicated that all tokoeka were alive after each toxic bait application (i.e. no tags were giving mortality signals).

A trip report with more detail on the tokoeka tagging can be found at DOC-7353344.

Tokoeka tagging data can be found at DOC-7353351.

Tokoeka signal check data can be found at DOC-7498019.

Bait interactions

Only cats, rats and possums were observed fully consuming bait or removing it from the camera field of view (Table 5). Possums and rats affected bait availability for cats, often consuming or removing bait before cats had a chance to encounter them. The maximum interaction of a native species with

bait was a tomtit that pecked a non-toxic bait on one occasion (Table 5). No tokoeka or deer were observed consuming non-toxic or toxic bait. The maximum interaction of tokoeka with bait was a bird mouthing and dropping a non-toxic bait on a single occasion, while the maximum interaction for deer was sniffing both non-toxic and toxic bait (Table 5). Further analysis of interactions is underway, and results are pending.

Master camera occupancy data can be found at DOC-7514586.

Bait interaction master data can be found at DOC-7514590.

Example footage of non-target interactions with bait can be found here.

Figure 8. Example of a possum mouthing (before dropping) a readymade feral cat bait during field trials on Rakiura in July-August 2023

Possum monitoring

Possum abundance was not affected by toxic baiting. Before toxic baiting, chew cards revealed 100% (±0% SE) tag line index (TLI) and 72% (±7% SE) possum abundance index (PAI). After toxic baiting, chew cards showed 100% (±0% SE) TLI and 78% (±7% SE).

Raw data and results summary for possum abundance can be found at DOC-7495087.

Rodent monitoring

Before toxic baiting mean rat tracking per line was 13% (±4% SE). Only rat, possum and invertebrate prints were recorded on tracking cards.

Raw data and results summary for rat abundance can be found at DOC-7495087.

Carcass residues

Only two fresh carcasses/animal body parts that were not collared cats were located inside the treatment area during or immediately following the toxin applications. One was a whole, freshly deceased rat, while the other was a piece of rat skin with a small piece of skeletal muscle attached, consistent with rūrū (*Ninox novaeseelandiae*) predation. Both rat samples tested positive for sodium fluoroacetate residue (Table 4). The stomach of the whole rat contained bait (Figure 9) and the concentration of toxin in the stomach tissue was also measured (Table 4).

Toxin and residue assay results can be found at DOC-7274324.

*Table 4. Concentration of fluoroacetate (µg/g) found in tissue of rats (*Rattus *spp.) found deceased inside the treatment area following application of readymade feral cat bait containing sodium fluoroacetate. Minimum detectable level of fluoroacetate was 0.001 µg g^{-1}.*

Sample type	Sample ID	Carcass weight (g)	Sodium fluoroacetate concentration (µg g^{-1})
Whole rat without stomach	K_line_rat	200	1.99
Stomach tissue from rat that consumed bait	K_line_rat_stomach	14.86 (intact stomach) 11.82 (stomach contents – almost entirely toxic bait)	36
Skin with scrap of muscle	D_line_rat	NA	0.02

9. Image of whole, deceased rat found inside treatment area of the readymade feral cat bait trial on Rakiura in winter 2023 showing the stomach that contains bait, dyed green

Table 5. Observed bait interaction for all species by bait type (non toxic and toxic) during readymade feral cat bait trial on Rakiura in Jul Aug 2023. Bird sp. Refers to unidentifiable passerine bird species

		Bird sp.	Blackbird	Cat	Chaffinch	Deer	Dunnock	Fantail	Kākā	Parakeet	Possum	Rat	Silvereye	Starling	Thrush	Tokoeka	Tomtit	Tuī
Non-toxic bait (n = 456)	Ignore	19	113	24	1	28	143	18		5	454	359		1	23	212	46	
	Sniff		2	22		15	2				139	104				20	4	
	Mouth/drop			2			2				6	18				1	1	
	Partial consumption			5							48	3					1	
	Full consumption			3							2							
	Remove from frame										1	7						
	Total non-toxic bait encounters	19	115	56	1	43	147	18	0	5	650	491	0	1	23	233	52	0
Toxic bait (n = 342)	Ignore	19	102	18		17	97	5	3	10	382	316	1		25	158	22	3
	Sniff			7		7	3				95	64			1	26		
	Mouth/drop			1							12	12						
	Partial consumption			2							37	3						
	Full consumption																	
	Remove from frame																	
	Total toxic bait encounters	19	102	28	0	24	100	5	3	10	526	395	1	0	26	184	22	3
Total bait encounters		38	217	84	1	67	247	23	3	15	1176	886	1	1	49		417	3

2.3. Improve understanding of bait degradation in the field

Methods

Degradation plots

Two degradation plots were established that broadly represented habitat classes in the treatment area: coastal forest and mid-altitude forest. Plots were steel mesh cages pinned to the ground to keep out possums and deer. Within the larger cages were placed a logger (HOBO RG3-M Pendant Event logger with Texas Rain Gauge (0.2 mm) and HOBO Base-U-4 Optic Base Station (Onset, Bourne, MA, USA) that recorded the mean temperature (to 0.01°C accuracy) every 60 minutes and recorded rainfall to 0.2 mm accuracy. A rodent-proof fine steel mesh cage housed baits (Figure 10). Five baits were installed at the start of each baiting round and were weighed at installation. Baits were sampled at 1, 2, 3, 5 days and the maximum bait deployment period in days following their installation (i.e. the final sampling point varied depending on the length of the current bait deployment). Baits were weighed and photographed when collected, then stored at -20°C until assayed for toxin concentration by the Toxicology Lab at Manaaki Whenua, Lincoln.

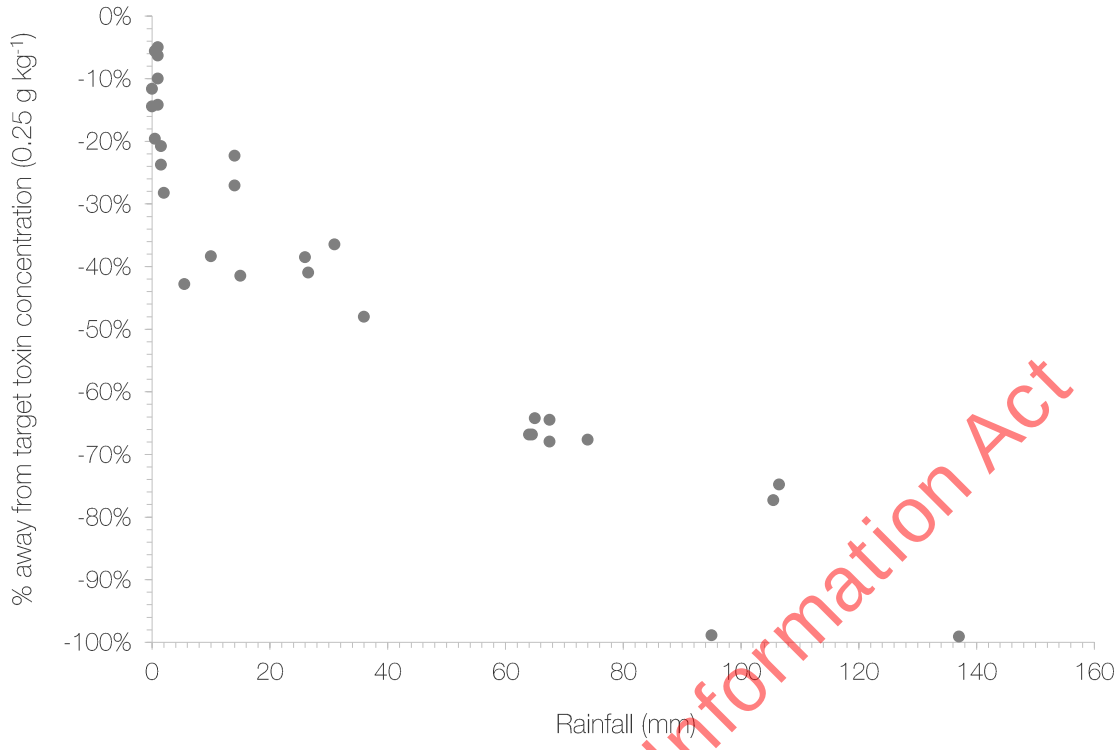
A task spec for the field degradation trial can be found at DOC-7379269.

10. Toxic readymade feral cat baits under a rodentproof cage as part of bait degradtion field trials on Rakiura during July August 2023

Results

Statistical analyses are currently underway, and preliminary results are presented.

The concentration of sodium fluoroacetate in baits declined following exposure to rainfall (Figure 11), with >50% of toxin lost following at least 60 mm of rainfall.



11. Concentration of bait as a percentage (%) of the target concentration of bait (0.25 g kg^{-1}) that were exposed to rainfall in field conditions during a field trial on Rakiura in Jul Aug 2023.

Rainfall and temperature data are stored at DOC-7497301.

Bait toxin concentration data are stored at DOC-7274324.

3. Logistics

The two forms of transport used were the DOC Rakiura Operations vessel Hananui, supported by dinghy transfers, and a B3 squirrel helicopter, often with an underslung load (Figure 12). The type of transport used was dictated by the needs of the work: the number of people, gear, locations of drop offs and pick-ups (Table 6).

Heli flights were all through 9(2)(g)(ii) 9(2)(g)(ii) Before the programme of work kicked off, we called the company to explain the programme of work and our needs as they do not typically have a machin 9(2)(g)(ii) Each individual trip was booked via Heli Order form, with liaison with the pilot the day before the flight. The cell reception in the field meant this was a relatively straightforward process for pick-ups.

The heli landing at the hunter hut (accommodation for the trial) was tidally dependent, and the helicopter company were opposed to landing on the sand even if it was available. The compromise was to land on the grass platform in front of the tramper hut and load a fadge of gear bound for the hut which was transferred by underslung load that the pilot could button off. On the return trip, one person remained at the hunter hut to hook onto the load, then walked over the hill to the tramper hut for pick up. Heli drop offs to Lucky and Murray beaches were used to limit dead walking for baiting runs and pick-ups from these locations were occasionally utilised when it made sense.

The Hananui was booked through the local Operations office, with liaison with the skipper(s) in the days leading up to the trip. There was a need to secure both the Hananui and a dinghy with separate skipper from the local office, which was difficult to fit around their work plans at times. The landing at Christmas Village is affected by north-west, northerly and easterly swell and wind, so consideration

was given to whether boat landings would be feasible. We were fortunate the weather was favourable on most days we required boat support, with just the time on the day that changed to best suit the tide and conditions.

Table 6. Logistics by trip for the readymade feral cat bait trial on Rakiura in 2023.

Trip	Task	Duration (days)	People	Date drop off	Date pick up	Mode of transport	Comments
1	Cat trapping	5	6	23/03/2023	28/03/2023	Hananui in Heli out	Pick up brought forward and switched to heli because COVID developed in team
2	Install TT	3	1	19/04/2023	21/04/2023	Walk in/out	
3	Install TT	3	2	8/05/2023	10/05/2023	Hananui in/out	
4	Kiwi catching	9	6	8/05/2023	16/05/2023	Heli in Hananui out	
5	Sausage/bait making Orillion (Wanganui)	3	3	22/05/2023	24/05/2023	NA	
6	Bait degradation Manaaki Whenua (Lincoln)	6	2	12/06/2023	17/06/2023	NA	
7	Bait/camera installation Prefeed 1	5	6	30/06/2023	5/07/2023	Hananui in (gear + some people) Heli in (some people) Heli out	Heli landed on beaches for in and out Difficult conditions for dinghy
8	Prefeed 2 Pre-operation possum and rat monitoring	4	6	14/07/2023	17/07/2023	Heli in/out	Heli incident at Lucky – see H&S section
9	Toxic 1 Mortality check + field degradation	3	5	22/07/2023	24/07/2023	Heli in/out Heli out	Half of team left in for mortality monitoring & stayed in for Toxic 2 baiting. Additional flight out for team member who got COVID.
		3	3	25/07/2023	27/07/2023		
10	Toxic 2 Mortality check + field degradation	3	5	28/07/2023	30/07/2023	Heli in/out	Half of team left in for mortality monitoring & stayed in for Toxic 3 baiting. Team that had been there the previous week for monitoring departed.
		6	3	30/07/2023	5/07/2023		
11	Toxin 3 installation Mortality check + field degradation	3	5	5/08/2023	7/08/2023	Heli in Hananui out	Whole baiting team left & new person came in for mortality monitoring & stayed in for Post-toxin rebait 1 baiting. Used Hananui to shift toxin freezer (containing waste & samples) and bring in more LPG
		5	1	7/08/2023	11/08/2023		
12	Toxin 3 removal Post toxin rebait 1	3	5	12/08/2023	14/08/2023	Heli in/out	Baiting team joined monitoring person
13	Post toxin rebait 2 Post toxin possum monitoring	5	6	22/08/2023	26/08/2023	Heli in/out	
14	Camera removal	4	5	1/09/2023	4/09/2023	Heli in Hananui out	Field camp at hunter hut was shut down; all gear removed.
15	Warning sign removal Carcass monitoring Kiwi transmitter removal	5	2	10/01/2024	15/01/2024	Hananui in & out	

4. Health & Safety

A Safety Plan specifically for the trial on Rakiura was prepared using Risk Manager (Safety Plan Summary – ID24654). The Rakiura Backcountry Emergency Response Plan (DOC-7364821) was adapted to include NET functions as well as Rakiura, and the Rakiura Operations Manager was briefed on this before baiting delivery. Boating was carried out under the Rakiura Marine Transport Risk Manager Plan (Safety Plan Summary – ID6490). Field safety intentions (template DOC-7364913) were filed with the NET emergency contacts, Rakiura Visitor Centre and Murihiku Duty Officer before each individual field trip.

Pesticide risks were managed using DOC's relevant Safe Handling Sheet (DOC-22716) from the Safe Handling of Pesticides SOP (DOCDM-22730) provided by the bait manufacturers Material Safety Data Sheet (DOC-6908118). Staff handling toxin held the appropriate Controlled Substance accreditation or were under the supervision of someone who holds this. There were no toxin-related incidents or accidents during this project.

Comms

Daily scheds via text were sent to the Murihiku Duty Officer due to difficulty with radio communication with Rakiura field base. Trip intentions were updated with the NET manager and emergency contacts, as well as the Duty Officer and Rakiura field base. Individual daily intentions were managed by the team in the field – radio scheds (via simplex) were attempted at noon and 3 pm. If no contact could be made with another team member then a text was sent to the team leader as a minimum. ETAs home were updated if a team member was going to be late or was going to take a different route than planned. Cell reception for texts was mostly good in the operational area; ridges/humps/higher points were generally reliable reception spots. There was adequate 4G reception at the hunter hut to check emails and weather.

Incidents

All incidents and accidents were recorded in Risk Manager. There were several minor incidents as a result of slips, trips and falls (strains and sprains), a minor medical incident (burn) and two trips had a COVID outbreak in the team. There was one major incident involving a helicopter, with a passenger exiting over rising ground. The incident underwent a Team Learning Process, which can be found at DOC-7426143.

One difficulty noted was that when someone from a different team/line manager puts an entry into Risk Manager it can't be linked to a particular project/risk plan and other teams can't view the entry. We relied on people letting us what had been entered into Risk Manager.

5. Costs

Costs were forecast to the best of our ability during planning and updated when known. More effort was put into accurately reporting major costs (e.g. bait, personnel, logistics, etc) than minor costs (e.g. incidental field equipment). Financial data management was important to feed into budget planning and reporting, as the project spanned multiple financial years. Some costs such as TOIL earned and daily allowances needed to be journalled across from other host codes if staff were in reporting lines other than NET (there is no other way to do this currently).

Table 7 Summary of costs by programme and financial year (July June) for the readymade feral cat bait trial on Rakiura

Row Labels	Sum of Cost TOTAL
2021/22	14850
Rakiura bait trial	14850
2022/23	130990.91
Bait development	49548.51
Rakiura bait trial	81442.4
2023/24	102619.75
Bait development	17200
Rakiura bait trial	85419.75
Grand Total	248460.66

More detailed cost breakdowns and summaries can be found in the Project Register at DOC-7041141.

6. Communications

A communication plan was drafted that identified all affected parties; it also shows planned and actual records of consultation and notification (DOC-7054703). A factsheet was used to communicate the purpose, timing and risks of the project with key stakeholders and any interested parties (DOC-7078391). Subsequent factsheet-type project updates were sent to stakeholders and interested parties following key steps in delivery (May 2023 update: DOC-7349665 and September 2023 update: DOC-7448170).

7. Consents

Table 8. Consents obtained for the readymade feral cat bait trial on Rakiura in 2023

Authority	Title	Link	Reference
EPA	HS3 application	DOC-7179281	APP204585; HSC100389
EPA	HS3 approval	DOC-7319058	APP204585; HSC100389
MPI – ACVM	Provisional registration application	DOC-7191793	V009683-01
MPI – ACVM	Provisional registration approval	DOC-7319099	V009683-01
DOC	Animal ethics application	DOC-7181101 DOC-7180805	AEC419 Efficacy readymade feral cat bait
DOC	Animal ethics approval	DOC-7201512	AEC419 Efficacy readymade feral cat bait
DOC	Animal ethics application	DOC-7182407	AEC420 Risk to kiwi readymade feral cat bait

Authority	Title	Link	Reference
DOC	Animal ethics approval	DOC-7312657	AEC420 Risk to kiwi readymade feral cat bait
DOC	Advice public health permission is not required (email)	DOC-7325273	NA
DOC	Advice resource consent is not required (email)	DOC-7261161	NA
DOC	Permission application	DOC-7343325	7369060
DOC	Permission assessment	DOC-7369063	7369060
DOC	Permission approval	DOC-7369060	7369060
DOC	Pesticide Advisory Group assessment	DOC-7353994	NA

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6. National Pest Control Agencies. *Possum Population Monitoring: Using Trap-Catch, Waxtag and Chewcard Methods. A Series: Best Practice* (Wellington, 2015).
7. Gilles, C. & Williams, D. *DOC Tracking Tunnel Guide v2.5.2: Using Tracking Tunnels to Monitor Rodents and Mustelids. Inventory and monitoring toolbox* (2005).

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Appendices

Expedition personnel

Table 9. Personnel involved in the delivery of the readymade feral cat bait trial and associated bait development

Trip	Task	Personnel
1	Cat trapping	9(2)(g)(ii)
2	Install TT	
3	Install TT	
4	Kiwi catching	
5	Sausage/bait making Orillion (Wanganui)	
6	Bait degradation Manaaki Whenua (Lincoln)	
7	Bait/camera grid installation Prefeed 1	
8	Prefeed 2 Pre operation possum and rat monitoring Warn sign installation	
9	Toxic 1 Mortality check + field degradation	
10	Toxic 2 Mortality check + field degradation	
11	Toxin 3 installation Mortality check + field degradation	
12	Toxin 3 removal and Post toxin rebait 1	
13	Post toxin rebait 2 Post toxin possum monitoring	
14	Camera removal	
15	Warning sign removal Kiwi tag removal Carcass monitoring	

Work planned vs actual

Table 10 Trip reports including task details and work planned vs actual for the readymade feral cat bait trial on Rakiura in 2023

Trip	Document link
Trip report – cat trapping	DOC-7312401
Trip report – kiwi tagging	DOC-7353344
Trip report – grid install & prefeed 1	DOC-7390821
Trip report – prefeed + CC + TT	DOC-7410962
Trip report – toxic 1 + signalling toxin 1	DOC-7448632
Trip report – toxic 2 + signalling toxic 2	DOC-7448634
Trip report – toxic 3 + signalling toxic 3	DOC-7448635
Trip report – post toxin rebait 1	DOC-7448639
Trip report – post toxin rebait 2 + CC	DOC-7448643
Trip report – final bait survey & grid shut down	DOC-7449075
Trip report – kiwi tag removal & carcass monitoring	DOC-7598402

Summary of effort

It took 3011 hours of field work to deliver the readymade feral cat bait trial on Rakiura, equivalent to almost 1.5 FTE.

*Table 11. Total effort to deliver the readymade feral cat bait trial on Rakiura as of 22/11/2023. Hour for the final trip in early 2024 (orange text) are not yet included. This does not include any project planning, trip preparation, analysis or reporting. CC = chew cards; TT = tracking tunnels; * = more detail in individual trip reports*

Trip	Task	Duration (days)	People	Date drop off	Date pick up	Average hours worked pp*	Average hours worked total	Average additional hours total	BDIL total	Additional hours coded against	NET staff	Threats staff	SSI staff	DOC casual (NET paying all hours)	Contractor	Contractor days	DOC days
1	Cat trapping	5	6	23/03/2023	28/03/2023	56	336	32	4	Donations	3	1	1		1	3	25
2	Install TT	3	1	19/04/2023	21/04/2023	24	24	0	0	NET				1			3
3	Install TT	3	2	8/05/2023	10/05/2023	26	52	4	0	Islands	1		1				6
4	Kiwi tagging	9	6	08/05/2023	16/05/2023	86	516	144	4	Islands	1		3		1	9	36
5	Sausage/bait making Orillion	3	3	22/05/2023	24/05/2023	43	129	9	0		3						9
6	Bait degradation MW Lincoln	6	2	12/06/2023	17/06/2023	51	102	11	0	NET	2						12
7	Bait/camera grid installation Prefeed 1	5	6	30/06/2023	05/07/2023	54	324	156	6	Islands	2	3	1				30
8	Prefeed 2	4	3	14/07/2023	17/07/2023	43	129	72	4.5	Islands		3					12
	Pre-operation possum and rat monitoring	4	3	14/07/2023	17/07/2023	43	129	72	3	Islands	2				1	4	8
9	Toxic 1	3	5	22/07/2023	24/07/2023	29	145	90	5	Islands	1	3	1				15
	Mortality check + field degradation	3	3	25/07/2023	27/07/2023	24	72	0	9	Islands		3					9
10	Toxic 2	3	5	28/07/2023	30/07/2023	27	135	15	5	Islands	1	3	1				15
	Mortality check + field degradation	6	3	30/07/2023	05/07/2023	48	144	0	0	NA	1		2				18
11	Toxin 3 installation	3	5	05/08/2023	07/08/2023	26	130	10	5	Islands	1	3	1				15
	Mortality check + field degradation	5	1	07/08/2023	11/08/2023	40	40	0	0	NA	1						5
12	Toxin 3 removal and camera rebait + CC	3	5	12/08/2023	14/08/2023	26	130	10	5	Islands	2	3					15

Trip	Task	Duration (days)	People	Date drop off	Date pick up	Average hours worked pp*	Average hours worked total	Average additional hours total	BDIL total	Additional hours coded against	NET staff	Threats staff	SSI staff	DOC casual (NET paying all hours)	Contractor	Contractor days	DOC days
13	Post toxin monitoring - non-toxic rebait 1 + CC	5	6	22/08/2023	26/08/2023	43	258	20	0	Islands	2	3		1			30
14	Camera removal	4	5	01/09/2023	4/09/2023	24	120	10	5	Islands	5						20
15	Warning sign removal + carcass monitoring + kiwi tag removal	6	2	10/01/2024	15/01/2024	48	96	0	6	Islands	1		1				12
Field hours Total						**761**	**3011**	**655**								**16**	**295**

Task specs

Table . Task specifications for individual tasks during the delivery of the readymade feral cat bait trial on Rakiura in 2023

Task specification	Document link
Camera/bait grid set-up	DOC-7378800
Leghold trapping trial	DOC-7295637
Warning sign install	DOC-7392597
Servicing bait and camera grid	DOC-7378904
Final bait grid service & grid pull in	DOC-7449087
Chew cards running	DOC-7391796
Data champion	DOC-7379464
Cat collaring	DOC-7295637
Kiwi tagging	DOC-7321091
Tracking tunnel install	DOC-7321242
Tracking tunnel running	DOC-7391796
Transmitter check + carcass recovery	DOC-7449080
Field bait degradation	DOC-7379269

Data outputs

These data are the one source of truth – DO NOT ALTER MASTER DATA – make a copy of data for individual analyses.

Table 13. Raw/master data outputs from readymade feral cat bait trial on Rakiura in 2023

Data	Link
Camera occupancy	DOC-7514586
Cat detection	DOC-7508833
Bait interaction	DOC-7514590
Rainfall & temp	DOC-7497301
Bait & carcass toxin concentration	DOC-7274324
Photos – bait degradation & carcasses	NET Q: folder
Cat GPS	NET Q: folder
Whole project spatial data	NET Q: folder
Rodent & possum abundance	DOC-7495087
Cat collaring/trapping	DOC-7305392
Tokoeka tagging	DOC-7353351
Tokoeka signals	DOC-7498019
Example footage cats & bait	Videos here
Example footage non-target species & bait	Videos here