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Lizard Pest Management Plan

Huia Replacement Water Treatment Plant - Lizard Salvage
Prepared for Watercare Services Limited

26 June 2024

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Executive Summary

The Huia Water Treatment Plant (WTP), located in the Little Muddy Creek catchment in Titirangi, Auckland, is nearing the end of its operational life and needs to be replaced. Watercare Services Limited (WSL) has a replacement WTP project which involves construction of a replacement WTP on a bush-covered site in Waima, adjacent to the existing water treatment plant.

Part of the overall mitigation strategy is to salvage indigenous lizards within areas of site works to prevent potential disturbance and mortality, with a goal of no net loss of lizards. As native lizards are susceptible to predation and competition from introduced pest species, the chosen relocation site for these lizards needs a strenuous Lizard Pest Management Plan (LPMP) developed, to ensure the best possible survival outcomes.

The Lizard Pest Management Plan for the release site must be implemented in advance of the vegetation works / lizard salvage. This plan will direct the pest control contractors to the location of pest management works, control devices to be deployed and maintenance / monitoring frequency.

This LPMP encompasses both the lizard release site (3.5 ha) and an adjacent buffer area of 50 m surrounding the site, leading to management across a total area of 5.7 ha. This report outlines the intensive pest control regime within this area, including:

- Target species;
- Control device spacings and service frequency (traps and bait stations);
- Monitoring methods;
- Duration and timing of control;
- Control targets and thresholds; and
- Data management and reporting protocols.

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1.0 Introduction

1.1 Project Background

Watercare Services Limited (WSL) operates the Huia Water Treatment Plant (WTP; Map 1), Auckland's third-largest water treatment plant, located in Waima. It treats approximately 20 percent of Auckland's water supply, sourced from the Upper and Lower Huia Dams and the Upper and Lower Nihotupu Dams. The Huia WTP was constructed in 1929 and is now nearing the end of its operational life and needs to be replaced. The proposed site for the new WTP is adjacent to the current WTP. It lies within the Little Muddy Creek catchment, the wider Manukau Harbour catchment, and is part of the Waitākere Ecological District (Map 1).

An Assessment of Ecological Effects (AEE; Boffa Miskell Ltd, 2019) was conducted to determine the ecological values present at the project site and any negative ecological effects resulting from the WTP upgrade. The AEE concluded that the Project Site was found to have a 'High' rating for three out of four assessment matters (rarity / distinctiveness, diversity / pattern, ecological context). The Project Site therefore achieves an overall ecological value ranking of 'Very High'. The primary adverse ecological effects of the building works to create the new WTP will result from forest clearance (the permanent loss of 3.5 ha of indigenous forest cover at the Project Site), as well as resulting edge effects and fragmentation resulting from the vegetation clearance, impacting lizard species that use this forest as habitat.

Forest gecko *Mokopirirakau granulataus*, elegant gecko *Naultinus elegans*, and copper skink *Oligosomoa aeneum* have been recorded in the wider Muddy Creek catchment. The Department of Conservation Bioweb Herpetofauna Database and Auckland Council lizard records within 20 km of the site include copper skink, ornate skink *Oligisoma ornatum*, striped skink *Oligosoma striatum*, forest gecko, elegant gecko and pacific gecko *Dactylocnemis pacificus*. Boffa Miskell completed four nights of spotlighting for aboreal lizards at Huia in 2022, during which seven forest geckos and three elegant geckos were detected. This indicates that the impacted WTP site is likely to contain lizards of these species. All native lizard species are 'absolutely protected' under the Wildlife Act (1953, s63 (1) (c)), and lizard habitats are protected by the Resource Management Act (1991) and administered by the Department of Conservation (DOC) and local authorities (Auckland Council), respectively.

1.2 Purpose of Pest Management Plan

Introduced mammalian predators have a considerable detrimental impact on populations of native flora and fauna, including lizards. Reducing these impacts via predator control is known to result in substantial benefits for native biodiversity. The methods needed to achieve the appropriate levels of control are also well understood and widely used. As the success of pest control and resulting biodiversity gains are readily obtained, measurable, and can be tracked over the long-term, undertaking pest control as a form of mitigation is becoming more commonplace around New Zealand.

Based on available pest management data, surveys, and known habitat preferences, rodents and mustelids (the primary predators of lizard species) are well established and reasonably abundant in the catchment. Effective pest control is therefore expected to have an immediate benefit on native lizards, including decreasing predation pressure, increasing reproductive success, and decreasing the impact of browse on native flora and invertebrates, thus increasing availability of food resources and plant survival. However, to be effective, pest control needs to be comprehensive, cohesive and maintained at regular intervals on an ongoing basis.

The Lizard Management Plan (LMP; Boffa Miskell, 2020) aims for no net loss of lizards from the WTP upgrade works. To mitigate effects on native lizards within the proposed site area, as many as possible will be salvaged before any works and released into a designated release site (shown on Map 2), as described in the LMP. However, it is likely that some individuals may be missed during the salvage, so for no net loss of lizards, or a net gain, further conservation action must be taken. This Lizard Pest Management Plan (LPMP) describes the approach for the management of pests within the lizard release site, to improve their chances of survival and future breeding success. All of NZ's native lizard species are threatened by predation, particularly by rodents. Proposed pest management is likely to decrease predation and competitive pressure on the Waitakere populations of these At Risk - Declining species.

2.0 Target Pest Animal Species

2.1 Rats

Three rat species have invaded and naturalised in New Zealand, with Norway rats (Rattus norvegicus) and ship rats (R. rattus) being the most common on the mainland. Rats are generalist omnivores; their diet includes seed predation and preying on small animals such as invertebrates, reptiles, amphibians, and juvenile birds. Indigenous lizard populations are negatively impacted by all three rat species (Hoare, 2006), and thus removal of rats will reduce predation pressures on lizard populations.

Norway rats are the largest of the rat species. As ground-dwellers, they pose significant threats to ground-inhabiting and nesting species (Amori & Clout, 2002). Norway rats are the most capable swimmers of the rat species in New Zealand, can swim up to two kilometres across open water (Russell et al., 2008), and are frequently found around wetlands and waterways.

Ship rats are very agile and are frequent climbers, preferring to nest in trees and shrubs rather than on the ground. They can be distinguished from Norway rats by their tail which is longer than their body length and large ears that can fold down over their eyes.

Rats will be controlled across the lizard release site and buffer via intensive trapping and toxic baiting.

2.2 Mice

The impacts of mice on native biodiversity (flora and fauna) as either predators or competitors is not yet well understood. There is some evidence to suggest mice are predators on native lizards, frogs, and invertebrates (Egeter et al., 2015; Norbury et al., 2014; Wedding, 2007), and mouse populations may increase when larger predators (particularly rats, mustelids, and feral cats) are removed from an area, resulting in additional impacts on prey species (Germano et al., in press).

Unfortunately, there is no effective large-scale mouse control tool (either trap, toxic bait or otherwise) currently available. Mouse control in this lizard release site will therefore be undertaken alongside rat control (using a combination of traps and baits), and their populations will be monitored via chew cards (with detections also possible on camera traps and novel real-time monitoring tools, if deployed in the future).

2.3 Mustelids

Three species of mustelids are present in New Zealand; stoats (Mustela erminea), ferrets (M. furo) and weasels (M. nivalis vulgaris). Stoats and ferrets are able to be controlled via trapping and use of some primary and secondary poisons, but there are currently few adequate control options for weasels (although some may be caught with the tools used for targeting rats and other mustelids).

Each species has its own unique set of behavioural and morphological characteristics:

- Stoats possess the typical ecological characteristics observed in many opportunistic species, such as their small body size, short life span and rapid reproductive cycle (Lough, 2006). Populations are typically unstable through both time and space, as their density and distribution are predominantly controlled by prey availability (King & Powell, 2007; Lough, 2006). Home range sizes vary significantly depending on a range of variables including sex, season, and food availability. In a study on the Otago Peninsula, the average home range size was 83 ha for female stoats and 133 ha for male stoats (Moller & Alterio, 1999). Stoats can cover long distances, and dispersing juveniles may come from over 20 km away (King & McMillan, 1982). Stoats can exhibit significant neophobia or weariness of new objects in their environment, which must be factored into control strategies.
- Ferrets are wide ranging with average home range estimates of 18–265 ha for females and 19–760 ha for males, although home ranges are smaller during the breeding season between August and February (Gillies, 2007). Juvenile ferrets may only move small distances (some have been recorded having home range lengths of only 100 m). Ferrets are typically wary of novel objects, which can pose an ongoing challenge to their control. This can be addressed by placing traps that are maintained to a high standard (as per the trap setting checklist in Appendix 1) and using large, fresh meat lures (preferably rabbit) and placing traps in locations within preferred ferret habitats.
- Weasels have a typically patchy distribution and populations are subject to rapid fluctuations in both numbers and extent (King et al., 2001). They can be found in farmland and scrub, on the margins between forest and open country (King, 2005; Strang et al., 2018). In New Zealand, birds, invertebrates and reptiles are a larger component of weasels' diets than in other countries (Strang et al., 2018), but primarily they eat mice and insects (King et al., 2001).

Mustelids will be controlled across the lizard release site, primarily via trapping.

2.4 Hedgehogs

Hedgehogs are mainly insectivorous but are proven to predate native lizards (Department of Conservation, 2021a). Hedgehogs are commonly captured in trap networks targeting rats and mustelids, which also means that traps triggered by hedgehogs are no longer available to these target species until the trap is checked and cleared. Reducing the hedgehog population will consequently increase the effectiveness of the trap network as well as reducing predation pressure on ground-dwelling lizards. Hedgehogs will be controlled via traps.

2.5 Wasps

German and Common wasps (*Vespula germanica, Vespula vulgaris*) have established in immense numbers across New Zealand since their introduction in the 1900s, resulting in New Zealand now having the highest density of wasps in the world (Barlow & Goldson, 2002). Their considerable impacts on New Zealand native forest ecosystems are becoming well understood.

Wasps outcompete a range of birds, lizards and invertebrates that also feed on honeydew, impacting entire ecosystems by reducing food available. The probability of survival for some particularly vulnerable invertebrate species is near zero unless wasps are significantly reduced; this impacts lizards that rely on these invertebrates for food. Although not as destructive, paper wasps (*Polistes chinensis*) were reported to collect an estimated 31-957 g of invertebrate biomass per hectare per season, with wasp nest densities varying from 20 and 210 nests per hectare in a Northland study (Clapperton, 1999).

Although the potential effects of wasps on reptile communities is not well documented, it is highly likely wasps pose an equally significant threat to reptile populations. Also note that wasps pose a significant health and safety threat to contractors and workers (including those undertaking pest management) and are therefore included in this pest management plan.

3.0 Area for Pest Management

The proposed lizard release site is 3.8 ha in size (Map 1), and is located between Laingholm and Parau, bordered by the eastern edge of the Lower Nihotupu Reservoir and Huia Road, to the south. The site will have a 50 m wide pest control ‘buffer’ around it to ensure a safe zone for the lizards exists if they move far from their original relocations, so the total area of pest control is 5.7 ha.

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Data Sources: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors, Boffa Miskell

Projection: NZGD 2000 New Zealand Transverse Mercator

DRAFT

LEGEND
- **Pest Management Area (380ha)**
- Indicative Lizard Management Area
- Extent of Construction Footprint
- Watercare Designation

PEST MANAGEMENT PROPOSAL

Pest Management Areas

Date: 27 June 2023 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Helen.Blackie@boffamiskell.co.nz | Drawn: HCo | Checked: HBI

Map 1

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Data Sources: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

Projection: NZGD 2000 New Zealand Transverse Mercator

HUIA WTP ENVIRONMENTAL COURT

Lizard Release Site

Date: 13 September 2023 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: HCo | Checked: SFI

4.0 Toxic Baiting Protocols

4.1 Bait Stations

A permanent bait station network will be established across the lizard release site, with the aim of targeting rodents and wasps (if monitoring indicates the necessity). Recommended bait station locations are described alongside the trap spacings in Section 5.0 and shown in Map 3. As mice are a target species in this plan, rodent bait stations are deployed on a 25 x 25 m grid. Vespex bait stations for wasps are on a 50 x 50 m grid.

Baiting should occur in seasonal pulses, with bait restocked in stations on the first and third weeks of January, February, April, August, and November, old bait should be removed in the fourth week of each of these months. During active pulse months, at every service older bait should be removed before replenishing new bait to keep it fresh and attractive to rodents.

Bait stations should be ground-based, run-through bait stations containing a toxin such as DoubleTap (diphacinone and cholecalciferol) bait, which targets all rodents. The baits' effectiveness at controlling mouse populations will depend on the density of bait stations. Double Tap does not require a Controlled Substance License to use and it is low residue.

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Data Sources: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Bait Station Locations 25m
- D Rat Trap Locations 50m
- DOC 250 Trap Locations 100m
- Vertex Wasp Bait Locations 50m
- Predator Management Buffer (50m)
- Indicative Release Site

HUIA WTP ENVIRONMENTAL COURT

Lizard Release Site Potential Trap Locations

Date: 11 June 2024 | Revision: 0

Plan prepared for Watercare Services Limited by Boffa Miskell Limited

Project Manager: ian.boothroyd@boffamiskell.co.nz | Drawn: LJa | Checked: LMa

Map 3

5.0 Trapping Protocols

Trapping is a great way to supplement toxin control and will also allow for control efforts to be extended for mustelids and hedgehogs. The traps recommended for use in this plan are based on those currently available at the writing, but they should be supplemented or replaced with improved tools with proven efficacy as those come to market. It must be noted that pest control tools and technologies are evolving at a rapid rate, with many new traps coming into the market. A review of emerging animal pest management tools and technology should be included as part of an annual review of the Huia WTP pest control programme, and new tools should be incorporated into the following years' animal pest management practice if suitable.

5.1 Trap Types and Recommended Use

There are multiple trap types available to target rodents, hedgehogs and mustelids, but those chosen for use must have passed the NAWAC protocol for all of the selected target species. Table 1 includes a list of traps which have passed the NAWAC guidelines for relevant target pest species.

***Table 1**: List of traps that has passed the NAWAC guidelines testing for target species. P = passed for that species.*

Trap	Ship Rat	Norway rat	Stoat	Ferret	Hedgehog
DOC 150		P	P		P
DOC 200	P	P	P		P
DOC 250	P	P	P	P	P
BT 200	P		P		
BT 250				P	
PodiTRAP				P	
Rewild F-Bomb	P	P	P	P	P
Goodnature A24	P		P		
Envirotools D-Rat 'Lumberjack'1	P				
Envirotools Supervisor MAX	P				
Victor Professional PCR mod	P	P	P		
Victor Professional	P				

Envirotools D-RAT multi-rodent traps (Fig. 1) are recommended for use on ship rats and mice, as they have an adjustable sensitivity setting to focus on one or both species. The majority of other trap types will not trigger on mice. D-RAT traps are also cost-effective and easy to install and use on trees or on the ground. These are best used in a 50 m x 50 m grid and can be alternated between being on a tree or on the ground to ensure ship rats and mice are both targeted. Only the mouse sensitivity setting should be used. Recommended lures for use in these traps include peanut butter and Connovations cinnamon smooth lure.

***Figure 1**: Envirotools D-rat trap mounted up a tree (picture from Envirotools website).*

DOC 250 traps or ReWild F-Bomb traps are a larger, ground-deployed trap that are able to kill rats, mustelids and hedgehogs (but not mice). Both these traps have passed NAWAC (National Animal Welfare Advisory Committee) guidelines as a humane kill trap for these species. To include hedgehogs the DOC 250 tunnel must have a slight entrance extension. One of these trap types will be deployed in a 100 m x 100 m grid. The best lures for these straps to attract the full range of pests include either Erayz jerky, Erayz paste, a hens' egg and peanut butter and/or POAUKU long-life lures. In spring / summer (August to February inclusive), traps should be baited with fresh rabbit meat, or salted rabbit if fresh rabbit meat is not available, to better target mustelids. Other options include long-life lure dispensers, such as the ZIP-motolure or Critter Solutions EzyLure. These lure dispensers can result in higher interaction rates and reduce rebaiting.

5.2 Trap Servicing Protocols

Trapping should occur year-round throughout the lizard release site to provide for continued suppression of pests. All traps need to be checked regularly, reset and re-baited when required, and always maintained to a high standard to ensure that:

1. Lures do not become depleted or rotten;
2. The trap is regularly tested to ensure it is mechanically sound including checking for worn pivots and weakened springs and that its set to the correct trigger weight;
3. Access to traps remains open i.e. the trap has not become overgrown, and if so, any obstructing vegetation is either sprayed or cut back;
4. Traps are secured to the ground with wire to prevent being disturbed and removed by pigs and possums; and
5. Traps are clean and free of algal growth or other substances / debris that may make it unattractive to the target animal.

All traps should be checked at least monthly, increasing to once per fortnight between August and March (inclusive), when lizards are more active. All data shall be recorded as per Section 8.0, on Trap NZ or a similar data platform. Changing between lure types (e.g. every 3 months), File Ref: \\bmlaklfs1\NAT_design$\2016\A16055O_KMu_Huia_Geotechnical_Investigations\GIS\A16055O_copy.aprx A16055O_Lizard_Release_Site_PestMonitoring_A4L 3:31 pm

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Data Sources: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Trail Cameras
- Chewcards
- Chewcard lines
- Indicative Lizard Release Site
- Predator Management Buffer (50m)

HUIA WTP ENVIRONMENTAL COURT

Lizard Release Site Pest Monitoring

Date: 11 June 2024 | Revision: 0

Plan prepared for Watercare Services Limited by Boffa Miskell Limited

Project Manager: ian.boothroyd@boffamiskell.co.nz | Drawn: HCo | Checked: LMa

Map 4

may help to increase trapping success by targeting individuals with differing preferences. Using multiple different lures in DOC 250 traps, such as both rabbit and an egg, will also likely attract a wider range of target species and individuals of the same target species with differing preferences.

Table 1. Summary of control tools and spacing for each target species at the Lizard Management Area, Huia. These tools should be updated as new technology becomes commercially available.

Target species	**Control tool**	**Spacing**	**Notes**
Rats	DOC250 or Rewild F-Bomb	• 100 m grid	Targets both Norway and Ship rats
	D-RAT trap	• 50 m grid	Alternate D-rat trap in tree and in tunnel on ground (all set to mouse sensitivity level)
	Toxin in bait station	• 25m grid	Simultaneously controls mice
Mice	D-RAT trap (mouse setting)	• 50 m grid (D-rat trap offset by 50 m every 100 m on the grid)	Alternate D-rat traps on trees an in tunnels on ground, all traps set to mouse sensitivity level
	Toxin in bait station	25m grid	Simultaneously controls mice and rats Refer to Map 4
Mustelids & hedgehogs	DOC250 or Rewild F-bomb	• 100 m grid	Controls rats, hedgehogs and mustelids. DOC250 trap may need some widening at entrance for hedgehogs.

6.0 Wasp Control

Control of wasps is limited to poisoning nests, toxic baiting and biological control (Potter-Craven et al., 2018). For large-scale operations, sustained control toxic baiting is most effective. Fipronil (Vespex) is highly effective at reducing wasp numbers while having low non-target species risks and is endorsed by DOC. It is recommended the Vespex Bait stations are spaced at 50 m intervals along existing trap and bait station locations. Placing stations near other control devices also reduces the risk from wasps to those servicing the wider control network.

For small-scale and direct control upon locating a nest, powdered insecticides containing permethrin (e.g. NO Wasps Eliminator) applied at the entrance of the nest is used to exterminate a nest.

Wasp nests will be monitored both before and after treatment with bait to determine success of the operation as per the standard Wasp Nest Flight Count Monitoring Method (DOC-2597036). If wasp activity threshold increases within one year, wasp control should remain in place for one more season.

6.1 Pre-monitor for Wasp Activity

To determine if wasp activity is high enough to undertake control, fish bait, plain raw chicken meat, or rabbit meat can be placed on a container lid, around noon on fine days, with 5 m intervals between bait. After 1 hour, the presence of wasps can be inspected and recorded at each lid. If more than 10 wasps are present per 20 lids, control will be undertaken.

6.2 Toxic Baiting Protocols

If monitoring deems it necessary, Common wasps and German wasps will be controlled via Vespex poison baiting and NO Wasps Eliminator powder for known nests. NO Wasps Nest Killer Aerosol will be used to exterminate paper wasp live nests found when deploying bait stations. NO Wasps Eliminator powder will be used for German and Common wasp nests.

Bait stations locations should be as per the following specifications:

- Bait stations will be spaced at 50 m intervals along trap and bait station locations for other target species (see Map 3). This is the standard spacing recommended for areas 3-7 ha in size.
- Wasptek bait stations will be nailed onto a tree approximately 100 - 150 cm above the ground, so they are easy to check and service on following visits. Using gloves, 20-30 g of bait will be placed into bait well supplied with Vespex bait, using the indicator line on the bait well for indication of 20 g amount. The bait well will then be placed into Wasptek bait station.
- Bait will be left in well for 3 - 8 days, depending on wasp activity. Baiting will occur between late January and late February for effective control. Control can be repeated annually or twice annually to include control in early April or four weeks after first application if high wasp activity persists. Bait will be left for a maximum 8 days before collection of remaining bait and disposing off in approved landfill.

6.3 Post-control monitoring

The same methodology for pre-monitoring will be used after each baiting operation. If wasp activity remains over the threshold of more than 10 wasps per 20 lids, further control will be undertaken.

7.0 Monitoring, Targets and Thresholds

7.1 Pest Animal Monitoring

Ongoing monitoring and adaptive responses are key to effective predator management. Within the Huia WTP lizard release site, monitoring tools will be used to monitor pest presence and assess their densities against the intended targets, and to initiate further control if thresholds are exceeded (section 7.3). However, it should be noted that pest monitoring methods are not currently refined for sites as small as what is proposed here, and as such methods may need to be adapted to fit within the area.

This section outlines the monitoring methods and protocols, namely for chew cards, camera traps, trap-catch indices, and new monitoring technology.

7.1.1 Chew Card Methods

Chew cards are a common, cost-effective, and sensitive detection and monitoring tool suitable for determining the presence, and provide a coarse index of relative abundance, of a range of pests, including rats, mice, hedgehogs and mustelids. Chew cards, rather than wax tags, have been found to be more effective at attracting rodents, and are recommended by DOC in their National Biodiversity Monitoring and Reporting Framework (Forsyth et al., 2018). Chew cards have been found to have higher rates of detections for mice than tracking tunnels, and correlate to tracking tunnel rates for rats (Sweetapple & Nugent, 2011). The higher rates of detections for mice makes them a suitable choice over tracking tunnels for this project.

At the lizard release site, three chew card lines space 100 m apart will be utilised, with chew cards spaced 25 m apart along each line, in line with the best practice for rodents (Ruffell et al., 2015). The line will need to be ground-truthed to ensure chew card locations are appropriate, accessible and in areas likely to provide preferred habitat for rodents. The same chew card line is to be used year to year to enable trend monitoring and comparisons, but may be repositioned in future if, for example, access becomes difficult.

Chew card monitors (of three nights each) will be repeated four times per year (simultaneously with camera trap surveys): February, May, August, and November. The three-night monitor is as recommended by Ruffell et al. (2015) for monitoring both rats. Saturation of chew cards (when pest densities are too high and bite marks from some species may obscure marks from other species) is not expected to be an issue at this site because of the thresholds for additional control ensuring that pest numbers are maintained at low densities.

An additional monitor using chew cards may also be required if the threshold values of rats or are exceeded (section 7.3). The follow-up monitor should occur 4 weeks after the additional control measures to ensure the abundance of the target species has been successfully reduced to acceptable levels.

On each monitoring instance:

- Deploy cards for three nights when a mostly fine forecast is expected (no heavy rain predicted), as per the standard methodology for calculating the CCI.
- Fill the internal channels of the corflute material with peanut butter as a lure. Alternatively, cards pre-filled with herbal peanut lure can be used (available from Connovation Ltd).
- Nail each card to the closest suitable tree trunk 30 cm above the ground using 50 mm flat head nails angled upwards at 30 degrees.
- Label cards in permanent marker with the location, line number, card number, date of deployment and date of retrieval.
- Retrieve chew cards after the seven-night period, then proceed to interpretation and analysis of bite marks.

Any bite marks recorded on the chew cards need to be identified to species level and CCI needs to be calculated to gain an estimate of relative population abundance for each target species.

For each target species:

- Count the total number of devices with bite marks of target species for each line. Assistance with bite mark identification can be found on the Landcare Research website (www.landcareresearch.co.nz).
- Divide the total number of devices with bite marks on each line by the total number of devices per line to get the proportion of devices with bite marks for each line.
- Calculate mean proportion of devices with bite marks for all lines for the site (i.e. the sum of the proportion of devices with bite marks of each target species).
- Multiply by 100 to get the CCI percentage.
- Calculate the standard error (SE). This is the standard deviation of the CCI / square root of the number of lines.
- Multiply the combined SE by 2 to calculate the approximate 95% confidence interval. Note that some statistical assumptions may be violated by the field layout, so the 95% confidence intervals are approximations only.

7.1.2 Camera Trap Methods

Cameras are much more effective for detecting larger pest species (i.e. mustelids) (Norbury et al., 2017), including in comparison to standard tracking tunnels (Department of Conservation, 2020; Smith & Weston, 2017; Dilks et al., 2020). This success of camera traps is likely in part due to the reduction of a neophobic response (the avoidance of new objects in the environment such as tracking tunnels) with this passive method (Smith & Weston, 2017).

Trail cameras should be set up with the settings described in appendix 3.

7.1.2.1 Camera spacing

Trail cameras aren't designed for use in an area smaller than 300 ha due to the likelihood of replication of pest animal detections and overrepresentation because of this. According to Gillies (2024) each line needs to be 1000 m apart to be independent. Because of this, they are unlikely to give accurate ideas of relative pest numbers in the lizard release site area but are still useful for collecting presence / absence data of different species so are still recommended for use here.

Thus, four cameras will be set up 150 x 150 m apart, situated centrally within the lizard release site (as shown in Map 4).

7.1.2.2 Timing and frequency

Camera trapping should occur four times each year, in February, May, August, and November. This information will help to determine pest presence and assist with determining where to focus control efforts (i.e. location of additional efforts).

On each instance, cameras should be deployed for 21 nights when fine weather is forecast, which is long enough to capture any target animals present in the area.

7.1.2.3 Camera deployment, orientation, and lure

Each camera should be oriented so as to standardise the size of the detection zone, i.e. placing cameras at the same orientation and height (Glen et al., 2013). Cameras should be at about 1.5 m off the ground (about chest height) and angled at 45 degrees towards the ground (e.g. Fig. 3). Cameras need to be securely mounted to a firm structure, such as a tree trunk. Cameras can be attached to trees using a screw-in tree mount and/or straps. If no solid structure is available at the desired location, a waratah or strong wooden garden stake (2.5 x 2.5 x 1.5 m is suitable for most situations) can be hammered into the ground. Cameras can be secured with a screw. Stakes will need to be pre-drilled to prevent the wood from splitting and hammered at least 50 cm into the ground, or more if the ground is soft or in an exposed location. Avoid positioning cameras directly into the sun (i.e. at sunrise or sunset).

A lure needs to be placed in the centre of the camera's field of view (e.g. Fig. 3) to increase the probability of detecting a target animal in the area, and also to encourage animals to pause in front of the camera, which increases the likelihood of capturing a clear image (Glen et al., 2013). A combination of Poa Uku lures, fresh / salted rabbit (Erayz), and/or eggs can be used. All lures need to be secured firmly to the ground, such as using chicken wire and pegging. An automated lure dispenser (ALD) such as ZIP's Motolure of the EzyLure dispenser could also be deployed for camera monitors. These supply fresh, edible lure daily and can increase encounter rates.

Figure 2: *Camera trap set-up with the lure (comprising 150 g fresh rabbit meat between two pieces of Connovation's Erayz wrapped in chicken wire) pegged to the ground c.60cm in front of the device. Image from DOC's interim camera trapping guidelines (Gillies, 2021).*

7.1.2.4 Image analysis

All camera images need to be manually viewed and scanned for appearances of target predator species (in particular stoats, ferrets, and feral cats). Cameras should be set to take two rapid-fire still photos per trigger event to increase the likelihood of capturing a clear, identifiable image. As such, animals captured in both images should only be counted as a single capture during analysis.

The camera trap index of relative abundance for feral cats, mustelids and rats is expressed as the mean number of a feral cat, stoat, weasel, ferret or rat detections per 2000 camera hours (2000 CH) per camera trap line (Gillies, 2021). This is calculated as follows:

1. Total the number of detections on each camera and total these for each survey line. Do this separately for each of the target species.
2. Calculate the number of hours each camera was operating during the survey and total these for each line. For the purposes of this index, assume the camera traps have been operating from midday of the day they were set, until midday of the day they were recovered. So, for a 21-night survey session each camera is assumed to have been operating for 504 hours, with 4 cameras on a line (4 x 504 hours) the total is 2016 camera hours.
3. If there is evidence to suggest a camera has malfunctioned during the survey, assume it was operating from midday of the day it was set, until either midday or midnight (whichever comes first) following the time stamp on the last photo taken. If no images are collected (including those of the operator placing or recovering the device) on a camera trap, assume the device has been inoperable for the duration of the survey.
4. Calculate the relative abundance index of the number of target animal detections (2000 CH) for each survey line based upon the following formula; do this separately for each of the target species: **Detections per 2000 CH = (number of detections / number of camera trap hours) × 2000**
5. Calculate the mean (average) number of target animal detections (2000 CH) over all the lines. To do this, add the number of target animal detections (2000 CH) from each line and divide the total by the number of lines. Do this separately for each species.
6. Calculate the standard error of the mean. The standard error (SE) is simply a measure of the precision of the mean. It is often very useful to express the mean number of target animal detections (2000 CH) plus or minus SE. If you use a calculator with statistics functions, you can calculate the standard deviation ($^{\delta}$n-1 button) of your sample (of the target animal detections (2000 CH) from each of your survey lines). The standard error can then be calculated from the standard deviation. The standard error is equal to the standard deviation divided by the square root of the sample size, which for these surveys is the square root of the number of lines. Do this separately for each species.

Note: this index may change based on any new best practice guidelines released by DOC.

7.2 'Smart' Monitoring Technology

In addition, new real-time monitoring technology will be incorporated into the pest plan as it becomes available, which will allow for instant (real-time) detection of pests and tracking of populations. New technologies also have the advantage of higher detections of all pest species, but particularly smaller species such as rats and mice. This greatly enhances management approaches by allowing rapid responses to pest increases, and the set-and-forget nature of these technologies also reduces human impact associated with frequent monitoring which has the potential to disturb / kill lizards.

7.3 Targets and Thresholds

Management targets in pest control relate to the “maximum allowable residual pest abundance targets” which allow native species to recover (Brown et al., 2015). That is, the management target for each species is the ideal goal that the control actions aim to achieve. The proposed management targets for rodents, as well as the thresholds for initiating additional control measures, are based on the Chew Card Index (CCI). If monitoring identifies that the targets are not met on any single monitor, this will trigger a requirement for further control.

For this project, targets have only been listed for rats and mice, as there are no suitable monitoring methods for a site this small for mustelids.

Note: *Some targets outlined in Table 2 are seasonal to best protect lizards when they are most active.*

Table 2. Summary of management targets, thresholds for initiating additional control and monitoring frequency for each target pest species within each pest control area.

Pest Species	Management Target	Threshold	Monitoring frequency
Mice	<5% CCI or TTI (year-round)	≥10% CCI or TTI (year-round)	Four monitors per year in February, May, August, and November.
Rats	<5% CCI (Nov-Feb); <10% (Mar-Oct)	≥ 5% CCI (Nov-Feb); ≥10% (Mar-Oct)	

7.3.1 Response to exceedance of targets

If monitoring identifies that the thresholds for control targets have not been achieved, this will trigger a requirement for further control. This use of thresholds facilitates adaptive management and ensures that pest populations are continuously and effectively suppressed. See Table 3 for the response measures to be undertaken for threshold exceedance for each target species.

Table 3. Summary of threshold exceedance response measures including additional control for each target pest species.

Species	Threshold %	Exceedance Response Measures
Mice	≥10% CCI (year-round)	• Trap checks and rebaiting of snap-traps in DOC traps and D-rat traps needs to increase to once every two weeks, if not already at this interval • Up to three additional ground-based toxic control operations will be repeated per year. A follow-up monitor 4 weeks after the start of any additional toxic control operations needs to occur to determine whether the mouse population has been successfully reduced to below the threshold.
Rats	≥ 5% CCI (Nov-Feb); ≥10% (Mar-Oct)	• Switch to a novel or new toxin. • Up to three additional ground-based toxic control operations will be repeated per year. • Trap checks and rebaiting of DOC traps and D-rat traps needs to increase to once every two weeks, if not already at this interval. A follow-up monitor 4 weeks after the start of any additional toxic control operations needs to occur to determine whether the rat population has been successfully reduced to below the threshold.

8.0 Data Management

Data recording will align with PF2050's Data Standards. The quick read guide to the Data Standards, and the Master Lookup Spreadsheet with value names, is available here on the PF2050 website. The one-page schema diagram of mandatory and optional data required by the Data Standards is also provided in Appendix 2.

All control data (including both trapping and toxic control), as well as all monitoring data, need to be entered into a single, cohesive data management system as soon after field work as possible. TrapNZ is the recommended platform, as it is widely used across New Zealand, user friendly, and can record spatial distribution of traps and catches.

The data management system needs to be set up as soon as possible. The GPS waypoints of all ground-truthed traps and their type need to be entered into the system. This includes traps that are either pre-existing or those deployed as per this plan.

All contractors and other persons undertaking pest control need to record all trapping data on the selected system. Each person / group that needs to access the system, will need an account and be instructed on how to enter the required information correctly.

For each trap check, all data needs to be accurate and complete, as per the minimum information to be recorded below:

- Date of trap servicing and time taken to complete trap / bait station servicing;
- Name of the trap servicer;

- Device location, unique identifier, model type and model name;
- Lure type and whether the lure was refreshed;
- Whether the trap has been triggered (trap status);
- Trap catch (species); and if possible / relevant: sex and age of individual, number of individuals, or record trap catch as zero if nothing is caught;
- Bait type and quantity deployed (for bait stations);
- General comments (e.g. if trap needs fixing or replacing, if bait is gone).

Maintaining accurate and precise records of both pest control and pest monitoring are crucial to evaluate the success of predator control at each site. Spatial and temporal trends in pest populations and catch rates can be identified in the analysis of this data, which can then inform future animal pest management decisions.

8.1 Data Reporting

An annual animal pest management report will be prepared by the pest animal manager appointed by WSL.

Each annual report needs to align with consent condition reporting requirements. At a minimum it should include:

- A summary of all pest control activities undertaken within the Lizard Release Site in the preceding 12 months, detailing dates, and methods of each control activity:
- Maps of control devices / area, labelled by type;
- Summaries of trap catch statistics by species (both target and any non-target catch), including by trap type, trap location, lure type as well as CCI, with comparison to management targets and thresholds for additional control;
- Summaries of results of toxic control operations, including target species, bait type and bait take;
- Any trends in the data, such as high-catch / high bait-take locations, the main species caught and comparisons to previous years;
- Any challenges / issues encountered in undertaking control or monitoring, and how these difficulties were overcome or if they remain ongoing.

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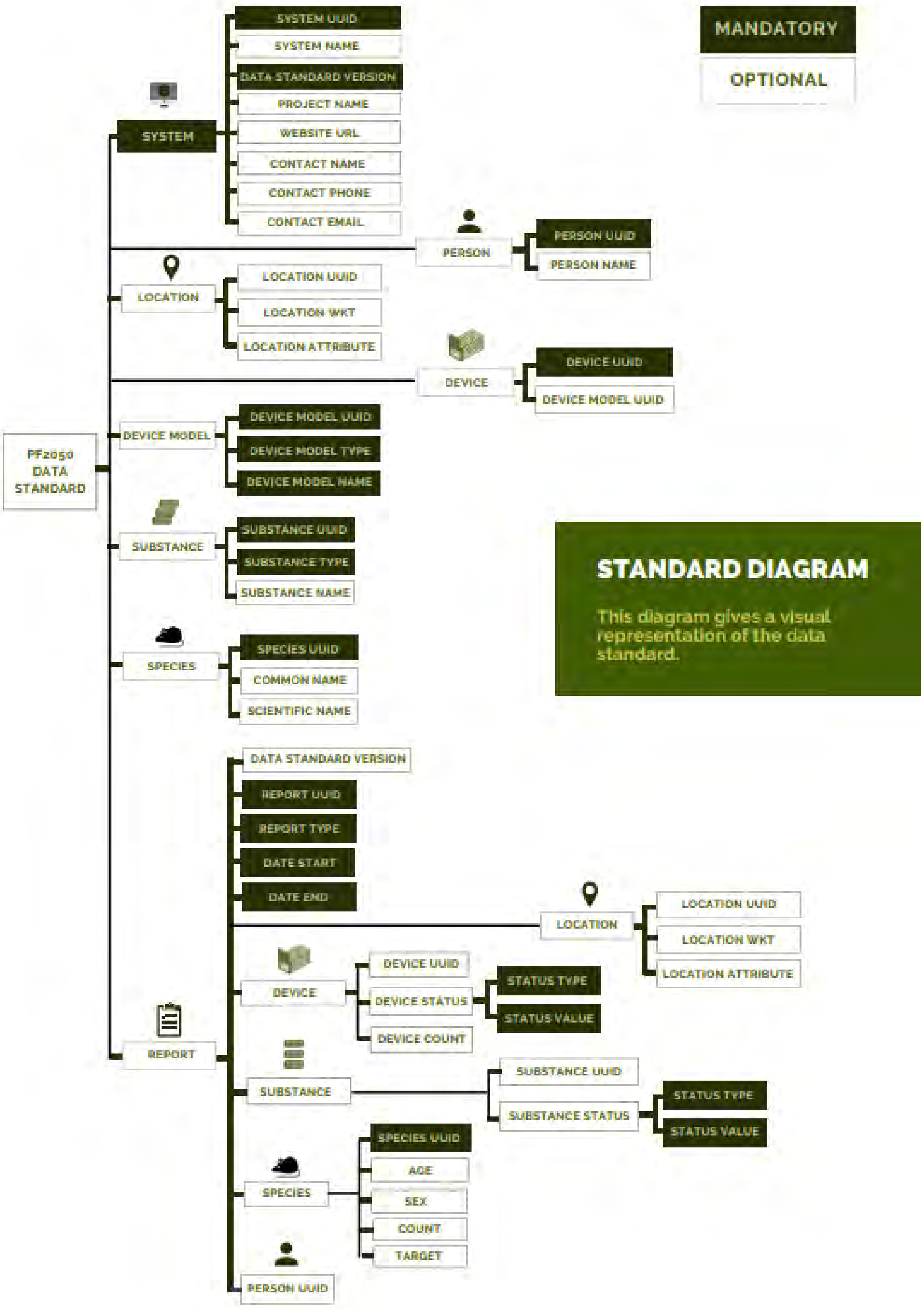
Appendix 1: Trap Audit Checklist

	Performance Standard	Evidence
1.	Trap is set correctly	a) Correct bait for the current month is positioned in the holder. b) Trigger plate is angled approximately horizontal and as close to the baffle as possible. c) All trap plates move freely when the trap is set (springs are tensioned in a set position) d) The trap box is marked correctly with the trap number.
2.	Trap is secured correctly	a) Trap is secure in within the tunnel and correctly positioned. b) All mesh is securely fixed to the trap box with no gaps other than the opening aperture which shall measure no greater than fifty millimetres square. c) Internal baffle is in line with the trigger plate d) Tunnel lid is secured firmly
3.	Trap functions correctly	a) The trap can be sprung by gently lowering a 100 g weight onto the distal end (end furthest from the hinge) of the trigger plate. b) When it sets off the moving parts do not touch any part of the tunnel or baffles c) Double set traps do not spring off 'sympathetically' i.e. when one trap is sprung by a dummy capture (e.g. rolled newspaper ~40 mm diameter) the other trap remains set. d) All moving parts on non-stainless-steel traps are lubricated with builder's pencil or graphite powder so that they move freely without binding when the trap is actuated.
4.	Trap is sited correctly	a) The trap box is positioned in such a way that it is unlikely to be damaged or accidentally sprung by stock and where located on visitor walking tracks is not obstructing passage. b) The trap box is seated firmly on the ground so that it is stable and does not move in any direction when moderately firm pressure is applied to it (palms placed flat on top of the box at opposite ends). c) Tunnel has been pegged to the ground if specified.
5.	Trap is cleaned correctly	a) The entire trap is substantially free of animal matter (fur, tissue and bone) from previous captures. b) Any uneaten bait and captures have been discarded at least 5m from traps and away from waterways. c) Both ends of the tunnel are clear of vegetation to 300mm. d) Tunnel is in good condition. e) Both ends of the tunnel are clear of vegetation to 300mm. f) Tunnel is in good condition.

Appendix 2: PF2050 Data Standards Schema Diagram



Appendix 3: Trail Camera Settings

The key settings to consider when setting up a camera trapping network for mustelids include:

- Trigger speed (the time taken from when an animal is detected by the sensor until it is photographed);
- Sensitivity (low, medium, or high amounts of movement required to trigger the camera);
- Type of sensor (passive infrared (PIR) vs microwave);
- Type of flash (white vs infrared);
- Type of image recorded (still photograph vs video of specified duration); and
- Interval (time between trigger events).

A camera trap to detect mustelids should be set to capture two rapid-fire still photographs per trigger event. Capturing two images improves the chance that an animal which triggers the camera is successfully caught and able to be identified to species level. Still images also do not require the same time-consuming analysis as video. The two photos are considered as one ‘capture’ if the animal appears in both images during analysis.

Cameras should have a trigger speed of no more than 1.6 sec, medium to high sensitivity, use a PIR sensor and initially use cameras with an infrared flash. If images taken with a PIR sensor are unable to be identified, a white flash should then be considered, however, a white flash is more likely to frighten animals (Glen et al., 2013). These settings are typically able to detect and allow clear identification of the key species of interest, including stoats and rats (Glen et al., 2013).

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