An Urban Predator-Free Blueprint

A model for eradicating rats and mustelids from urban areas

PREDATOR FREE WELLINGTON

Predator Free Wellington

Version 1

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Photo: Ian Robertson

About this blueprint

This document is a practical guide to the eradication of Norway rats (*Rattus norvegicus*), ship rats (*Rattus rattus*), stoats (*Mustela erminea*) and weasels (*Mustela nivalis vulgaris*) for urban regions of Aotearoa New Zealand. It details a summary of our current best practice knowledge based on the experience gained by Predator Free Wellington (PFW) between January 2019 and October 2024. It is intended to be a broad overview of some of the important considerations for carrying out an urban eradication project, including:

- Planning your project
- Engaging with community
- Understanding rat behaviour
- Staff and volunteer management
- Data management
- Eradication methodology
- Biosecurity

This blueprint reflects what we have learned to date. We know how to effectively remove these target animals, but our next step is to discover how we can do this faster and more economically. There will be future versions of this blueprint that incorporate our ongoing discoveries and innovations. By sharing our learnings and supporting one another, we can collectively work towards Aotearoa New Zealand's ambitious goal of becoming predator-free by 2050.

Note:

We use a number of unique terms in this blueprint which have been coined by Predator Free Wellington in order to describe our model. Definitions of these terms can be found in the contained glossary.

The term 'eradication' is traditionally used to describe the complete and permanent removal of a species from an area. This term is used here as its meaning is widely understood; however we acknowledge that in our urban mainland context, our definition differs slightly to that of more isolated areas. In a peopled landscape there are risk factors we cannot control, and there will be incursion events requiring us to constantly defend and maintain our 'eradicated' status. An alternative term that is increasingly being used for situations such as ours is 'elimination'.

Contents

1. Background

Aotearoa New Zealand's unique biodiversity is in crisis. Our proportion of threatened indigenous species is the highest in the world, in large part due to the suite of mammalian predators introduced by people. In 2016 the New Zealand government announced the Predator Free 2050 initiative, which aims to remove weasels, stoats, ferrets, rats and possums from the country by 2050, in the hope of protecting and restoring our taonga species. A number of large landscape projects were launched soon after to try to understand how this goal could be achieved.

Predator Free Wellington Limited (PFW) was formed in 2018 with the ambitious goal of making Wellington the world's first predator free capital city, a place where our native species and communities can thrive. The project is a collaboration between various organisations, community groups and the public, managed and led by Predator Free Wellington Ltd, a charitable company supported by Wellington City Council, Greater Wellington Regional Council, NEXT Foundation, Predator Free 2050 Ltd and Taranaki Whānui ki Te Upoko o Te Ika.

Our project is a world-first multispecies eradication in an urban environment, something that before now has only been achieved on offshore islands and fenced sanctuaries. PFW set out to create the blueprint on how predator eradication might be achieved in urban areas across Aotearoa. The project area includes 30,000 hectares and an estimated 70,000 households. It stretches from Miramar Peninsula in the east, over to the south-west corner of Mākara and up State Highway 1 to the border with Porirua City.

The project was designed with a phased approach: Wellington City has been divided into five large operational areas, beginning with the 1000-hectare Te Motu Kairangi, Miramar Peninsula (Phase 1), and progressing west, suburb by suburb. Phase 1 commenced in 2019 and was completed late 2023, with the successful removal of rats and mustelids. We are now working in the second phase of the project, known as Phase 2, which runs from the north of the CBD to Island Bay in the south.

Since the beginning there have been two arms to the project – the technical eradication operation and a targeted community engagement strategy. The technical plan was based on a 'remove and protect' model (Bell, Nathan & Mulgan, 2019), which involves the complete removal of the target species from an area, protecting that area from reinvasion, and rapidly detecting and removing any invaders. The engagement arm focuses on involving community environmental groups, households and businesses via a communication and engagement strategy. Community always had to be at our core. Methodologies currently used to eradicate pests from offshore islands, such as helicopter toxin broadcast, were never going to be feasible in highly populated areas. Our challenge was to build a method endorsed by our communities, towards an outcome they could take pride and guardianship of.

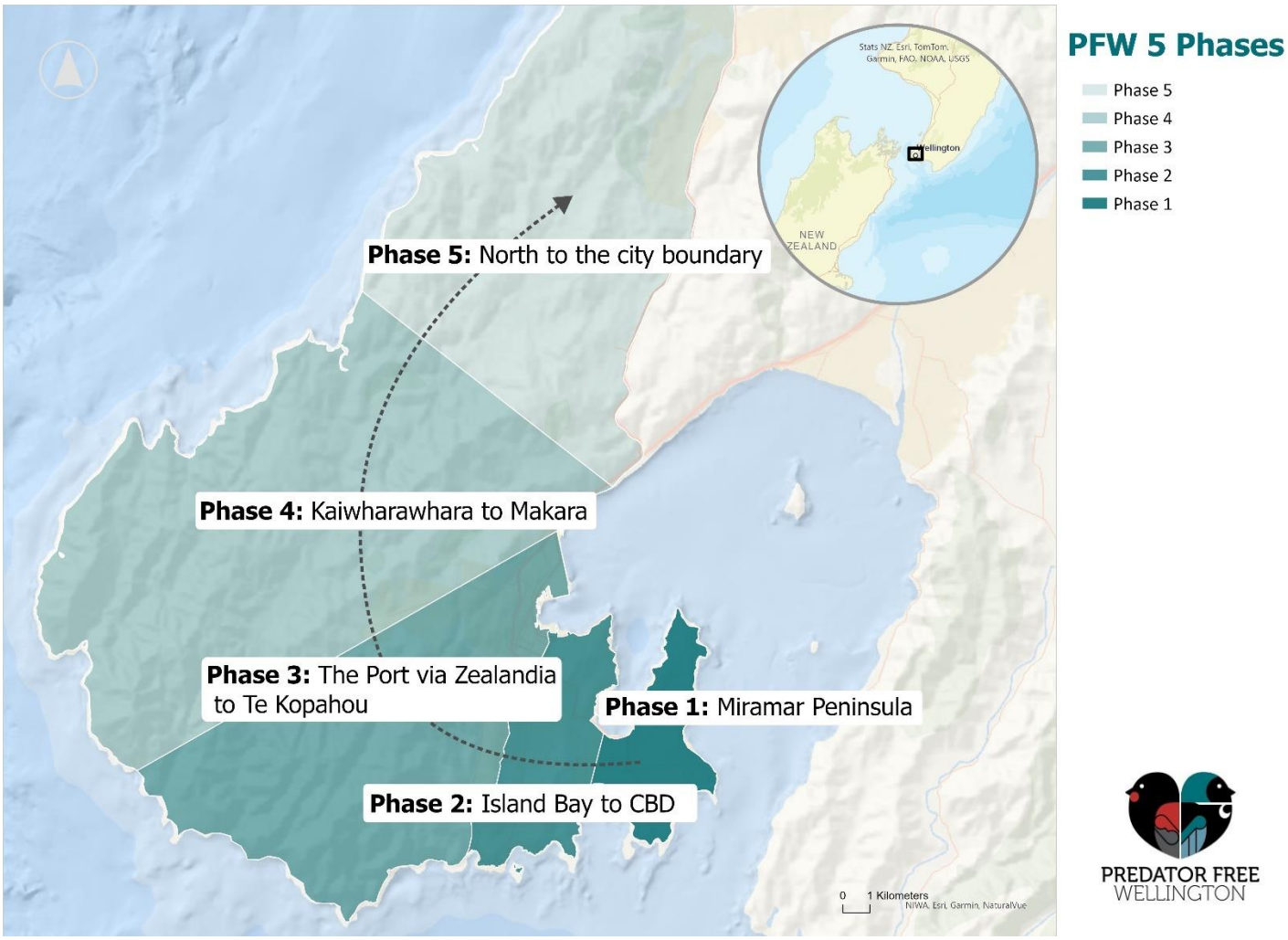

Figure 1: *Map showing the 5 Predator Free Wellington project phases, beginning with Miramar Peninsula and progressing west.*

Phase 1: Miramar Peninsula

Urban eradication of this scope has never been undertaken before, so our first few years were spent developing a successful method. There were three primary reasons Miramar Peninsula was chosen as our proving ground. Community groups have been predator trapping across Miramar since 2007, and the predator free social movement was well underway, with over 5000 rats removed in the three years leading up to the eradication. This was invaluable to the initial community drive and social licence needed to attempt something groundbreaking. Geographically, Miramar also offered a significant advantage. Being a peninsula surrounded by water on all sides and connected to the rest of the city by a narrow isthmus, Miramar could be defended more easily from reinvading predators. The isthmus is punctuated by Wellington Airport, creating a concrete expanse to further deter ingress from the target species.

The peninsula was also a good representation of the wider Wellington City – it contains a mosaic of industry, business and residential suburbs, spanning both ends of the socio-economic spectrum. It encapsulates a range of habitat types and topographies – flat, hilly, cliff, coastal, farm, forested and

varying degrees of urban development. If we could achieve predator freedom there, we knew a city-wide eradication was possible.

Target species

PFW aims to eradicate (or maintain the absence of) all the Predator Free 2050 target species from Wellington: rats, mustelids and possums. The target species of Phase 1 were Norway rats, ship rats and weasels. These had known populations within our operational area, and the goal was to eradicate them and then maintain and defend these areas from reinvasion. Possums were already eradicated from Miramar in 2006 by the Greater Wellington Regional Council, ferrets and kiore are currently not present in Wellington City, and stoats had no detectable presence on the peninsula. Norway rats and weasels were both considered successfully eradicated from Miramar within the first year of the operation. Ship rats posed a far more significant challenge, taking us a further three years to remove.

Miramar is now in a state of 'Biosecurity', being declared predator free and actively defended from reinvasion. We've already detected and removed several invaders, including multiple rats and a young male stoat. Subsequent phases of the project will also target Norway rats, ship rats and weasels, but will expand to incorporate stoats and possums wherever these are encountered.

Where are we now?

We are currently working in Phase 2, 'Island Bay to CBD', a 1400-hectare area incorporating 14 suburbs and home to 60,000 people. It has similar topography to Phase 1 but with some additional challenges, including a zoo, university, hospital and a much wider (and harder to defend) 'front line'. Our methodology and knowledge have evolved a great deal since we began in 2019. After successfully proving the method in Miramar, the goal for Phase 2 has been to refine it, making it faster and cheaper to achieve. This is where our current focus lies, alongside maintaining the predator free status of Phase 1.

Our approach has adapted to be far more responsive, flexible and data-driven: we monitor activity daily, building up a picture through multiple layers of monitoring, and we innovate and problem solve constantly. We're also more proactive, using dog detection, habitat classification and forecasting tools to pre-emptively adjust our approach to new areas. We've built a tight knit team of rat specialists, a dedicated troupe of volunteer rangers, and a vigilant community network who are our eyes and ears, reporting possible sightings to us every month. The bounce-back of our native taonga has been amazing – we've seen a 91% increase in native bird detections in Miramar, and a 200% increase in tree wētā. Anecdotally, we're seeing species previously absent from the peninsula such as kārearea (New Zealand falcon), kākāriki (red-crowned parakeet), kākā (bush parrot), ruru (morepork, native owl) and geckos.

This blueprint aims to summarise our recommendations and methodology, to the best of our current knowledge. This method will continue to adapt as our tools and expertise evolve, but we hope other communities can use it as a guideline to achieve predator freedom in an urban area.

2. Planning an urban eradication programme

Project preparation

It's important to understand the ecological, physical and social environment of your project during planning – What are the local attitudes towards predator eradication and toxin? How will habitat influence rat distribution? What non-target species do we need to consider? How will we manage logistics such as access and parking? In an urban area, social licence may influence which methods are acceptable when relying on permission to work on property from residents. It's important to build an understanding of the local attitudes towards your proposed methods, and have flexibility built in. Surveys and small-scale trials are a great way to test the waters.

The table below covers a broad overview of the preparation stages for an urban eradication. The exact structure and timeline will vary widely depending on the social and environmental landscape of individual projects. At each stage in the process, we recommend an adaptive management approach. Allow plenty of flexibility in timelines and methodologies to evaluate, revise and adapt. If a particular approach isn't working, don't feel obliged to see it out: you will regularly need to pivot and consider new ideas. Seek technical advice regularly – someone external can bring a fresh perspective and help challenge your thinking and assumptions. Be open minded to ideas from all levels of the project – field observations and perspectives are vital to understanding issues and opportunities.

Eradication planning stages

1. Scope	• Set project vision and target species • Understand project landscape • Identify key partners and stakeholders • Write initial scope and objectives
2. Consultation & research	• Engage & consult Iwi, Territorial Local Authorities (TLAs) & other key stakeholders • Collaborate with technical experts • Establish connections through PF2050 networks • Identify major risks & potential challenges • Form draft methodology • Identify resource & budgeting requirements • Survey community attitudes • Perform feasibility study
3. Plan	• Review & revise methodology • Prepare operational plan • Form Technical Advisory Group (TAG)

4. Refine	• Technical peer review of operational plan • Consult key parties • Select tools • Refine & finalise plan • Define key questions and uncertainties for testing • Outline team structure & role responsibilities
5. Prepare	• Establish funding commitments • Build relationships with partners & stakeholders • MOH consent (if required) • Procurement & contract setup with suppliers • Depot establishment, fleet and equipment • Prepare key documents (e.g. Health & safety, Standard Operating Procedures) • Establish data management systems & technology requirements • Hire community engagement, data management and leadership staff
6. Implement	• Community engagement • Gather landowner access permissions • Commence small-scale trials of methodology & conduct baseline monitoring • Build understanding of habitat and environment
7. Analyse & adapt	• Review data from trials & adapt methods as needed • Hire remaining field staff • Allocate time for training and upskilling • Commence operational plan, but maintain a constant feedback cycle of data review and adaptation

Operational plan

An operational plan should be developed with plenty of flexibility built in. You may want to incorporate the following elements:

- Target species
- Operational area, broken into management zones
- Planned methodology
- Tools & equipment
- Field work
    - Planning logistics
    - Installation

    - Servicing
    - Detection
    - Signage
    - Line preparation
    - Auditing
- Proposed timeline
- Team structure
- Data management
- Community engagement and involvement
- Health and safety
    - Hazard identification
    - Reporting
    - Public safety & concerns
- Biosecurity

Depot establishment

The PFW depot had the following basic requirements for up to 30 staff:

- Workshop (including designated space for all regularly used equipment and personal gear cubbies)
- Backup stock storage
- Office space
- Locked toxin storage and waste bin
- Freezer for dead animals, frozen bait and DNA samples
- Dissection bench
- Drying room for wet gear
- Large meeting room to fit whole team
- Smaller break-out meeting rooms
- Kitchen
- Bathrooms
- Vehicle parking (11 project vehicles + personal staff vehicles)

There are many health and safety compliance considerations including fire extinguishers, evacuation and emergency procedures, flammable storage, appliance testing, ventilation and heating, among others. Basic technology requirements include good Wi-Fi/internet connectivity, assigned laptops and phones, Microsoft Teams meeting facilities and a large screen (or projector).

Equipment & tools

It's important to set up contracts with suppliers to ensure a reliable supply of products. Running out of key materials (such as toxin) can put a halt to the whole operation, so establish a good inventory system,

order well in advance and keep plenty of backup stock. It is worthwhile running a proper procurement process to compare supplier quotes and acquire bulk goods for the best price.

When selecting your traps and bait stations, safety considerations must be balanced with effectiveness. Many tools on the pest-control market were developed for suppression, not eradication, and their effectiveness may be limited. This is covered in more detail in the section on rat behaviour.

In addition to the obvious tools (traps, bait stations, lures, toxin and monitoring), some of the equipment used by PFW is listed below:

Personal packs

- Silky saw and/or secateurs
- Hammer, multi-tool
- Compact electric drill & bits
- Tag pens (black and white)
- Roll-top waterproof dry bags for toxin and waste bait
- Ziplock bags (for carcasses), labels
- Knife
- First aid kit
- Battery pack & phone charger cable
- Weight strings (to calibrate traps)
- Trap safety catch
- Personal locator beacon (if out of cell coverage)

Peripheral equipment

- P.P.E. – rubber gloves, hand sanitiser, insect repellent, sunblock
- Rubbish bags
- Poison warning stickers and trap labels
- Nails, screws, metal pegs and bungy cord for securing devices
- Cable ties
- Flagging tape
- Letterbox message cards
- Signs, backing boards & waratahs
- Batteries, SD cards, wooden stakes (for cameras)

Uniform

- Rain jacket and waterproof over trousers
- Sunhat, beanie
- Socks, gloves
- Tramping boots/trail shoes
- Winter uniform – base layer thermals, long pants, fleece jumper, windbreaker
- Summer uniform – lightweight short & long-sleeved tops, shorts
- Utility vest or bumbag
- Hi-vis vest

Project area management

The PFW project area is broken into 3 levels of divisions for easier management:

- **Phases:** The broadest tier - large project areas (in our case 1000 hectares or more) to be targeted over 1-3 years.
    - **Districts:** Phases are divided into logical management areas (150 – 350 Hectares) to be eradicated successively. In a built-up urban area this may incorporate one or several suburbs.
        - **Zones:** Districts are further broken into areas of approximately 40 hectares called zones. Zones are managed somewhat independently through the eradication process described below.

Remove and protect model

PFW uses a 'rolling front' approach: beginning eradication in one zone (usually the most easily defendable from reinvasion) and progressively moving across the landscape, eradicating zone-by-zone successively until each district is completed. This results in a moving 'front-line' with zones in active eradication along the leading edge, and zones behind which are eradicated and being defended from reinvasion. New zones can be successively activated as prior zones are declared eradicated and staff resources are freed-up. A bit like puzzle-pieces fitting together, the eradicated area will grow over time, until eventually the whole operational area in the current phase is complete.

This approach has been successful; it allows us to work intensively in a small area to reach eradication, without biting off more than we can manage at one time. Spreading ourselves too thin, over too large an area, was one of the reasons ship rats weren't eradicated from Miramar Peninsula on the first attempt. Intensive suppression of rats is achievable at a large scale with current tools, but the intensity required to remove every last individual makes eradication orders of magnitude more difficult at this scale. A manageable zone size will vary between projects depending on factors such as team size, resources, geography and level of urban development.

Geography can be utilised to divide the project area into logical phases for planning and to be more defensible from reinvasion. Where possible, it's useful to make these divisions along major landscape features such as roads, breaks in habitat type or waterways.

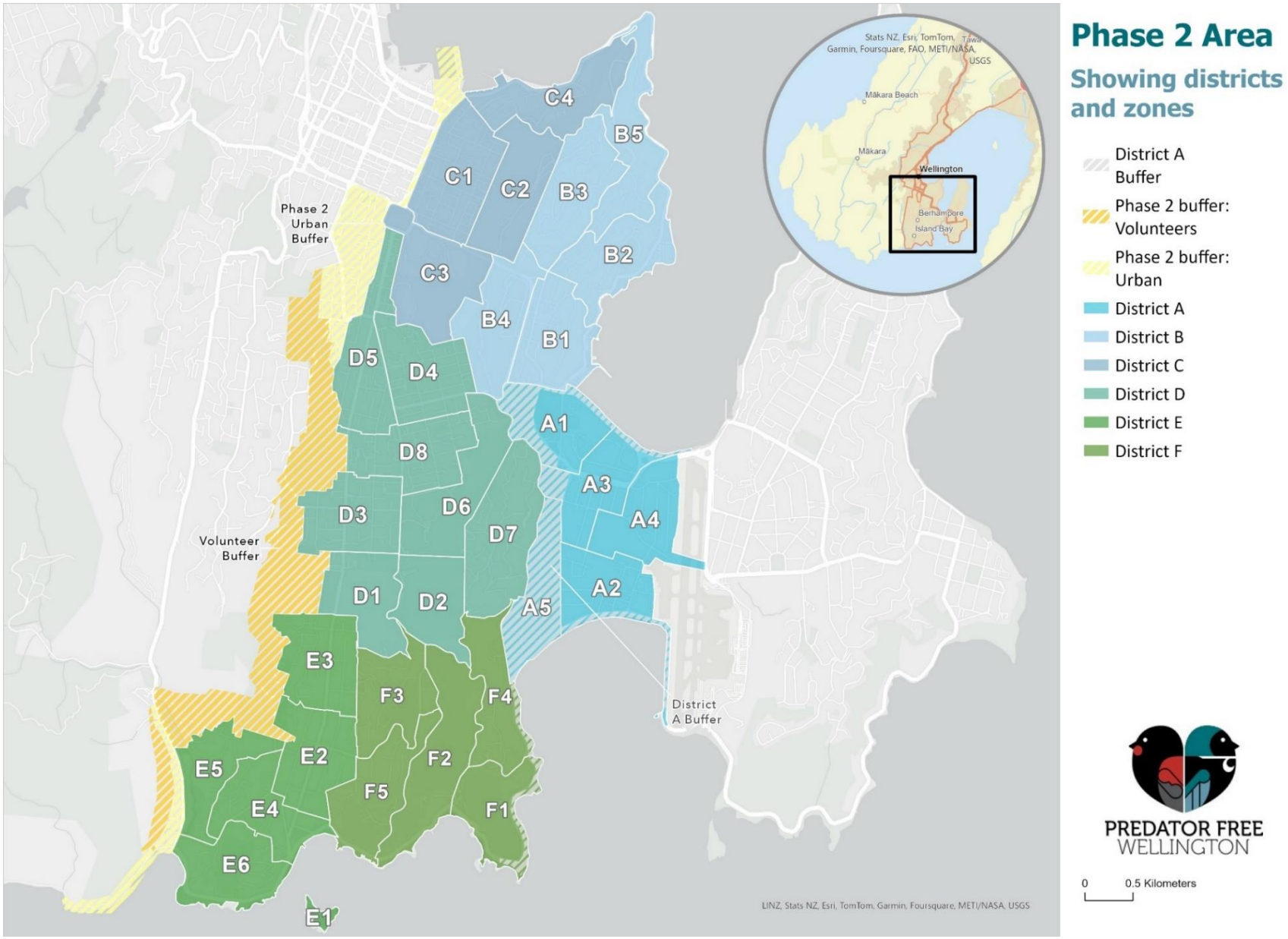

Figure 2: *Map showing the 1400-hectare Phase 2 project area, divided into Districts (A - F) and Zones (numbered).*

3. Rat behaviour

Neophobia is the fear of anything new or unfamiliar. For rats neophobia can cause hesitancy to investigate a trap or bait station. We must overcome their natural sense of caution by appealing to their sense of curiosity – making devices as enticing and non-threatening as possible.

Device architecture

Device architecture is a term we use to refer to the structure and shape of traps or bait stations. It's most commonly used in reference to how 'closed' or 'open' the device structure is, which influences rat interaction. A bait station or trap with closed architecture is typically an enclosed box, requiring the animal to enter through a small opening to interact with a trap or bait housed inside (for example, a DOC200 wooden trap box, or PelGar Rat Station). A bait station or trap with open architecture has the trap or bait more exposed, with a minimal housing or shroud to meet legal requirements (e.g. a KK bait station, RatAbate striker).

Figure 3: *The spectrum of device architecture of bait stations and traps, in relation to structure, effectiveness and risk.*

Not all devices are equal in their effectiveness at removing rats; we consider them to be on a spectrum of effectiveness based on various features of their architecture. PFW have found that in general, the more open architecture a device has, the more willing rats are to interact. Closed architecture devices are still effective for many rats, but there seems to be a small proportion who are just not willing to enter an enclosed device. Alongside this spectrum of effectiveness there is also a scale of increasing risk – the effectiveness of open devices must be balanced with their increased risk to people, pets and non-target species, as well as greater exposure to the elements which can degrade bait or lure quality. A balance

must be struck between the effectiveness of devices at removing rats and an acceptable level of risk, with health and safety always being the top priority. PFW currently use the following approach:

1. Safety and project reputation are top priority. Closed, locked, and secured devices should be used wherever necessary – for example properties with dogs, young children, or in public spaces close to walkways.
2. Where non-target risks are lower (e.g. bush areas away from public tracks, backyards with no pets or children) and property permissions allow, more open and effective devices can be used. In these scenarios we often use tunnel bait stations. These are larger stations with bigger openings and have a clearer line of sight through the device, but are still safe to use in many cases.
3. We allow the bulk of the rat population to be removed by the devices above, which in some cases is sufficient to reach localised eradication. Where monitoring data indicates we haven't been able to remove all rats from an area, we then look at swapping devices for more open architecture ones on a case-by-case basis. This relies on an evaluation of the risks, landowner permissions and non-target species at each site, and one of several possible devices chosen as a result. When applied with caution, in the right location and context, open bait stations such as KKs and RatAbate Strikers can be used safely in many situations to remove the last remaining rats. Placement can also be adjusted to help offset the risk of open architecture devices, for example, placing them up in trees out of reach of pets or children, or further shrouding them using natural materials such as logs or vegetation.

Habitat

For an urban eradication it is important to understand what habitat types are present and how these will influence rat activity, and consequently your device network. Wellington City comprises a mosaic of man-made and natural landscapes, including hills, suburbia, forested reserves, dense urban development and coastline. These landscapes offer a range of different habitat types, which vary in their topography, vegetation, food sources and level of disturbance, among other factors. It's therefore not surprising that while rats have been found across all habitats, their population density has varied significantly between habitat types.

The table below summarises some of the broad habitat categories present in Wellington, and their associated level of rat activity, informed mostly by our experience with ship rats. Based on the commonalities between habitats with similar levels of ship rat activity, favourable habitat seems to be related to dense vegetative harbourage, low proximity to human disturbance and available food sources. Man-made habitats appear to be less favourable to ship rats than natural habitats.

Rat activity level	Habitat types
Low	• Highly developed or built-up urban areas, consisting of low greenspace and dominated by buildings, concrete and structures • Managed greenspace with minimal cover or shelter, such as mown lawns or ‘tidy’ gardens. • Unmanaged grassland or pasture • Exotic pine plantation/forest with minimal understory



Moderate	• Vegetation forming moderate coverage • Regenerating native forest • Beach and coastline especially with boulder banks (esp. Norway rats) • Less managed, ‘messier’ gardens or greenspaces comprised of trees and/or shrubs that provide moderate ground cover.



High

- Vegetation forming dense coverage with low disturbance
- Dense growing vines such as Cape ivy (*Senecio angulatus*), banana passionfruit (*Passiflora* spp.)
- Native early-successional coastal vegetation comprised of species such as harakeke/flax (*Phormium tenax & P. cookianum*), toetoe (*Austroderia* spp.), taupata (*Coprosma repens*), karo (*Pittosporum crassifolium*). Generally dense and low-growing.



Microhabitat

Habitat is complex and within these environments microhabitat is just as important to rat distribution. A microhabitat in our context is habitat at a finer scale, such as a few square metres, which might differ from the habitat around it. Favourable microhabitats will often be the areas used most within a rat's home range, as a food source, den, cache or shelter. Areas of good microhabitat (such as a compost bin) might exist within unfavourable habitat (such as a highly developed urban area). Areas of human habitation can intensely compartmentalise a landscape with houses, roads, fences, domestic pets and plentiful food sources provided by people and vegetation. This can reduce rats' home-range size, as all its resource needs can be met locally. Some rat-favoured microhabitats we've observed are:

- compost bins
- wooden logs or stumps with hollows
- patches of dense vegetation, such as a bank of Cape ivy or a pampas plant
- discarded human building materials or rubbish such as sheets of corrugated iron
- green waste, branch or wood piles

Ship and Norway rat differences

It's worth understanding the distribution of the different rat species within your target area. Norway rats and ship rats will display differences in behaviour which can be utilised to help target them. In the hilly, vegetated residential suburbs of Wellington ship rats appear to be more numerous than Norway rats, but we see the opposite trend in flat, highly developed urban suburbs, where Norway rats appear more common. Depending on your project area, this could cause huge variation in the difficulty and expense of eradication.

Norway rats (*Rattus norvegicus*)

Norway rats have been found throughout the urban environment, but relative to ship rats seem to be less abundant, and have a stronger association with human presence, open and exposed areas and coastlines. Norway rats have been found nesting quite happily amongst busy urban areas with frequent vehicle and foot traffic, and lining their nests with human rubbish. They are much more commonly seen and reported by members of the public compared with ship rats. They'll more confidently cross open, exposed urban areas such as roads and carparks, and are more likely to stow away in vehicles. Because of these behaviours they have been a higher incursion risk into eradicated areas.

Norway rats will climb but are not as adept at it as ship rats. They're commonly found along the coastline, particularly areas which allow them to burrow, such as boulder banks or packed earth. Dog detection is very useful to locate burrow systems in these areas, so they can be targeted directly. Traps or bait attached to stakes or wires can be lowered into burrows. Burrow systems can be formed quickly and are sometimes extensive – we found one system with 7 entrances which housed an adult rat with juveniles. Compost bins also make favoured homes for Norway rats, allowing them to burrow but also providing an easy food source. Encouraging people to rat-proof their compost bins is worthwhile.

Norway rats were much easier to eradicate from Miramar Peninsula than ship rats, with most (or possibly all) gone within six months using Protecta Sidekick bait stations (square, lockable bait boxes). This may have been due to their closer association with people, and therefore being less averse to interact with novel, plastic bait stations (i.e., lower neophobia). However, we have had several instances of single Norway rat incursions which have been very difficult to kill, requiring months of persistence, indicating not all are easy to remove. In these incursion events the rats kept to a defined home range once established. They appeared to centralise around a single burrow system, roaming the coastline by about 600 metres in each direction, but not appearing to head inland. Norway rats are generally larger than ship rats, so in some instances increasing the entrance-hole size of devices resulted in catching a Norway rat which had previously evaded us.

Ship rats (*Rattus rattus*)

Relative to Norway rats, ship rats have a stronger association with densely vegetated and less disturbed areas. They are not so strongly associated with people, preferring to cluster in areas where plants provide shelter. Banks overgrown with exotic vines are a favourite, as are dense areas of coastal scrub

full of harakeke/flax, taupata, karo and pampas. Ship rats are excellent climbers, nimbly using branches to feed in the canopy or move through the environment. As they're not generally burrowing, ship rats will nest or shelter in wooden stumps or log hollows, in trees, under dense vegetation or discarded materials such as corrugated iron, or among piles of branches or green waste.

Ship rats are best targeted by placing the control devices in their preferred habitat, but minimising disturbance and vegetation clearance where possible. This can cause challenges for access where the terrain is very steep and vegetation dense. Ship rats have been far more difficult to eradicate from Wellington than Norway rats – they're often harder to physically get to, more abundant and seem more neophobic, possibly due to being less exposed to people and novel objects. A wider variety of devices has been necessary to remove all ship rats; some individuals appear unwilling to enter an enclosed device. One positive is that once eradicated, ship rats appear to be less likely to reinvade, due to having less of an association with people and vehicles who might inadvertently transport them.

Distinguishing features

Visual differences of rats or other target species can be worth noting to connect breeding events or relate trapped individuals to those spotted on trail camera. These can be distinguishing features such as scars, injuries or colouration. Wild Norway rats are generally all the same colouration; however we've observed some variants in Wellington. Pied individuals with large brown and white patches have been found across several suburbs, as have fully pale leucistic rats. These variants may be descendants from escaped or released domestic rats. Ship rats have 3 different colour variations, of which *rattus* has been least common in Wellington:

- *rattus*: uniformly black back, uniformly grey belly
- *alexandrinus*: brown back with long black guard hairs, uniformly grey belly
- *frugivorous*: brown back with long black guard hairs, uniformly white or cream belly

We're unsure whether these variations are tied to any behavioural or other differences.

4. Community engagement

From the beginning, the PFW kaupapa (purpose) has had community at its heart. The project has two interconnected branches – the technical arm for achieving eradication and the community engagement arm, and both have been crucial to our success. Below we briefly cover our engagement approach, but more detail can be found in this report (Whitburn & Shanahan, 2022). Community engagement is one of the first stages of an urban eradication to commence, but it is crucial throughout all project phases. It incorporates:

- Building and maintaining relationships with landowners, schools, residents, businesses, volunteers, interested parties and stakeholders
- Consulting and informing communities on eradication methods and activities
- Gaining permission to access and operate on private land
- Community outreach (information sessions, event stalls and education)
- Responding to enquiries and resolving issues.

It is important to adequately resource community engagement. An urban eradication project will fail without successfully building and maintaining public support and trust. It is well worth hiring specialist community outreach staff who are personable, confident, strong negotiators and skilled at public relations. Part of PFW's success in positive community relations has been from building a working relationship alongside Wellingtonians and fostering a sense of community ownership and pride. A lot of this momentum was already building in the years leading up to the eradication, through local initiatives to remove introduced predators and restore native wildlife by volunteer trappers, ZEALANDIA, Department of Conservation and local council, among others.

Across our entire operational area we have over 60 community trapping groups – that's one for every suburb in Wellington and most of the reserves in between. Some of these groups were active long before our organisation began in 2018, and they have paved the way in Wellington's journey towards predator freedom. Because of this, public awareness, acceptance, and support of the PFW project was high, and the time was right to take the efforts to the next level.

Landowner access permissions

We use the term 'permission gathering' to describe the process of obtaining consents to access and operate on private properties. We ask permission for properties to host bait stations, traps and monitoring devices for the duration of the eradication project. Our approach is to go door-to-door, having in-person conversations with landowners, businesses, and schools. We recommend this approach as it offers several advantages, allowing us to:

- Build trust and rapport face-to-face,
- Ground-truth locations and get to know the local area before field operations commence (e.g. noting accessways, public toilets and hazards),

- Read and respond to tone or body language,
- Gauge level of understanding, and provide extra context where needed,
- Resolve residents' specific concerns, questions, or requests,
- Identify good rat habitat and prioritise these properties,
- Use visual or verbal cues to tailor potential benefits to that individual (e.g. decrease commercial pest control costs, increased biodiversity, reduce house damage, improve fruit harvests),
- Canvas residents' knowledge on local target species activity,
- Form connections with local social networks,
- View and discuss potential locations for a device,
- Flag properties with language or other barriers to communication and use translation software where possible.

Our approach to community engagement varies depending on the property type:

Major landowners

Councils, Government organisations and larger scale businesses and land users are each allocated a single relationship lead. These major land parcels are given early consultation, and a spreadsheet used to record correspondence. In-person meetings and updates are scheduled where possible.

Community services & outreach

Education facilities, community centres and small businesses are visited by community engagement staff to explain the project and negotiate access. Special access requirements are accommodated where required. In some cases, this includes site-specific inductions, additional safety equipment and limited hours of visitation.

Tailored presentations are delivered to schools, preschools, community centres, community groups and businesses to inform and build support. Stalls or public talks are hosted to target specific groups, such as educating dog owners on how we minimise risks to pets. Community centres are valuable hubs, and community coordinators hold a wealth of knowledge on local areas and demographics.

Residential

In Phase 1 the primary method for engagement with residents was by door-to-door visits. The flow chart below (Figure 4) outlines the general approach. Property owners and/or tenants can grant permission for a property. Staff are made easily identifiable, for example wearing branded uniform, hi-vis vests and ID cards. They also carry exemplar devices or photos with something for scale, so people fully understand what to expect. When having conversations with landowners it is important to cover the key points in the first 30 seconds, so it's made clear we aren't salespeople or fundraisers. This assumption can lead to a cold reception at first, but in most cases dissipates once people understand our intention, and that our service is free. The general doorstep message is something like:

"Kia ora, my name is ____ and I work for Predator Free Wellington. This year we're running an eradication project on Miramar Peninsula to get rid of all rats, stoats and weasels, with support from the Council. The plan is to install traps and bait stations across the whole Peninsula. These stations are totally free, safe for use around pets and kids, and we'll do all the work to look after them. We need as many properties on board as possible in order to target every single rat's home range, and this will help our native wildlife return. We'd like to ask whether your property could be part of this project, by hosting one of these stations somewhere in your garden."

The message is sometimes modified, in some cases emphasising this is a world first with positive outcomes for local biodiversity; in others emphasising that we will get rid of the rats from their home and garden for free. In general, we've found the former to be more useful in higher socio-economic suburbs where knowledge of the Predator Free movement seems to be higher. The latter has been more useful in lower socio-economic areas where there is a high proportion of council housing, immigrants and more reported issues with rodents indoors. The Miramar Peninsula contains the two suburbs that represent the lowest, and highest socio-economic levels in Wellington.

We aspire to open and honest communication and don't shy away from discussing toxin use, to help reduce any stigma or possible negativity. We emphasise that eradication should reduce the need for long-term toxin use, and that when used safely and responsibly, risks are very low. We also engage with local vets to get advice on how we've worded our communication, especially around our explanations of toxins and potential impacts on pets.

Most engagement is done during weekdays between 9am and 5pm, with some evening and weekend work where required. Evening visits are easier and safer during spring and summer months when daylight hours are longer. Permissions via email, text message or phone call are easier for some residents, especially those who work during the day.

In Miramar, we had three full-time community engagement staff working for four months to secure approximately 3000 property permissions. A goal of 10 permissions granted per day was established for each staff member. This goal was easy to achieve at the beginning, with up to 20 permissions being granted some days. However, once the easily obtainable permissions were secured (those keen to support the project and home during the day) the number per day reduced as the remaining sites required repeated follow-up. We've since found a daily goal for the number of properties visited is more consistently achievable.

In lower socio-economic suburbs of Miramar, volunteers delivered a flyer to each letterbox with a photograph of the engagement staff, contact details and a brief description that we will be making the area rat free, there was no cost, and we would be visiting households over the coming weeks. From this we received a number of enquiries from people wanting to be involved, even before visits had commenced. It also meant when we did visit people, we were recognised and they had some awareness of the project, so were more receptive. This, along with posting on social media, Neighbourly, and placing flyers and posters in local community centres seemed to get community conversation going in preparation for our visits.

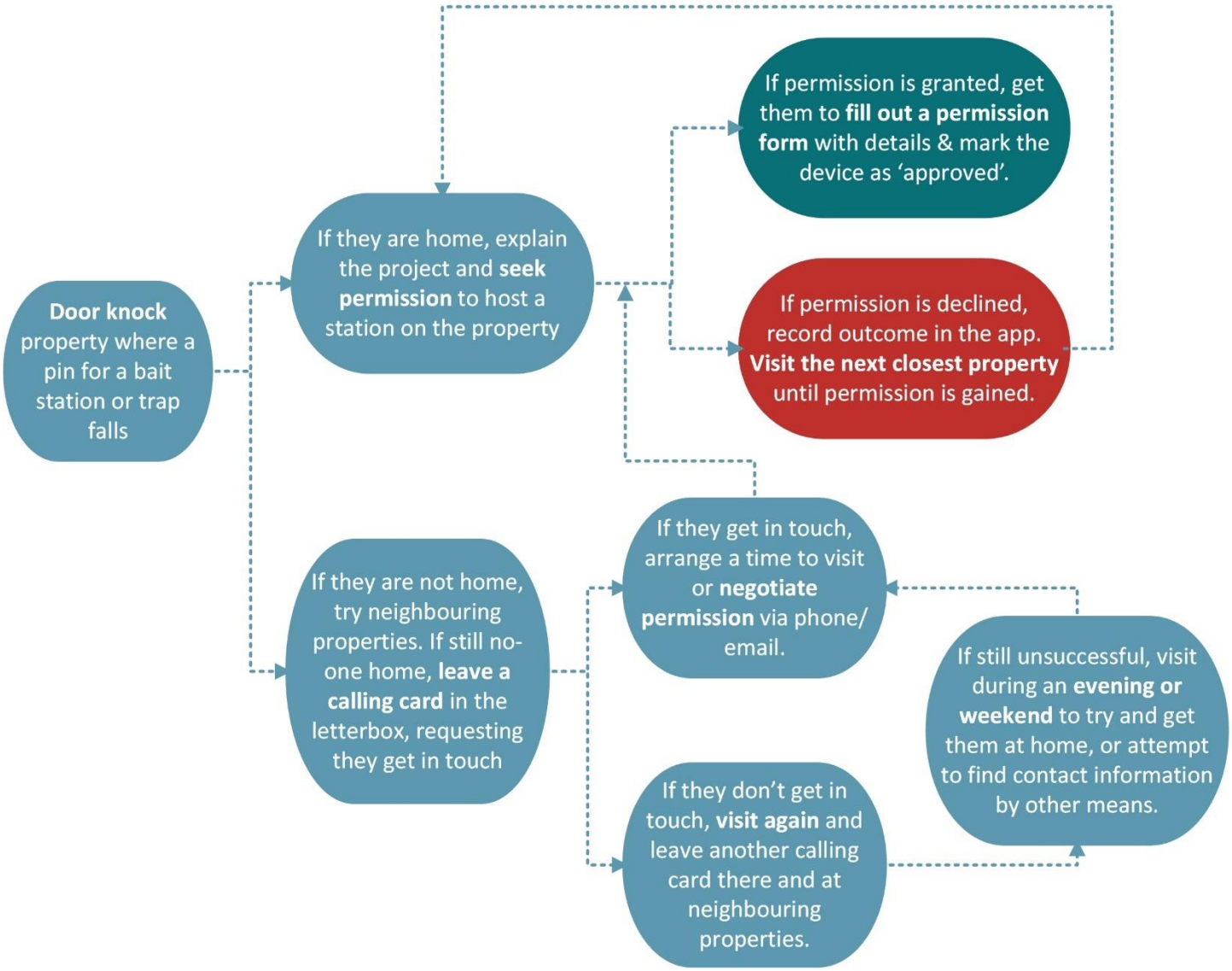

Figure 4: *The process of door knocking to request access permissions from properties.*

The methods we now use have evolved. As we've built awareness and trust in the wider community, we've been able to transition to an online permissions process. We have an online platform that allows residents to opt in and give land access permission. This significantly reduces the labour impact, which is essential when doing this at scale. We also attend many fairs and events to promote and 'sign people up' to participate in the project. We still do door-to-door visits before devices are installed, and where additional permissions are needed. The personal approach still offers the greatest impact, our field staff carry the torch and have excellent interactions with residents daily.

Resources

Physical resources

1. **Factsheet:** A double sided A4 guide for properties involved in the project, with a question-and-answer format, and contact information.

2. **Flyer:** An A5 four-sided booklet with general information on the project covering what, why, how and when the project will take place, and photos of the devices to be used.

3. **Calling cards:** An A6 "Sorry we missed you!" letterbox card with lines for a personalised message, staff member name, and contact information.

4. **Sign-up form:** A digital agreement containing fields for:

- Name
- Address
- Phone number/s
- Email
- Consent to:
    - bait stations
    - traps
    - trail cameras
    - dog detection
    - access through property
    - pruning of vegetation for access, if required
- Bait type (block or pellet)
- Locked devices required?
- Hazards
- Nut allergies
- Dog information
- Whether staff should knock when visiting
- Any specific entry requirements
- Whether they would like further updates or opportunities for involvement
- Signature
- Date
- Staff member name
- File/image upload

5. **Posters:** These are placed in public spaces such as noticeboards, community centres, or businesses.

Digital resources

6. **Website**: the Predator Free Wellington website covers information on the project, FAQs, resources and the ability to sign up.

7. **Social media:** media outlets such as Facebook and Instagram are utilised to distribute updates and call upon people living in the eradication area to get involved.

8. **Contact**: An 0800 number and email address for general enquiries.

9. **Email**: PDFs of the flyer and factsheet emailed to residents who couldn't be visited face-to-face. Periodic email updates are sent to those who request them.

10. **Fulcrum or Trap.NZ:** Phone and desktop apps are used to manage and store permissions (www.fulcrumapp.com; www.trap.nz). The planned device network is overlaid on a satellite map using pins. These pins are coloured to denote their permission status: planned, in progress, declined, approved, not required or installed.

11. **Contact directories:** Through Greater Wellington Regional Council we're able to access the LINZ landowner database to determine land parcel ownership. In some cases this can be used in conjunction with the White or Yellow Pages to contact properties.

Dealing with access challenges

Special requirements

In general, residents are not offered scheduled days, times or forewarning of visits to check traps and bait stations, to increase the ease and flexibility of field operations. However, where this is specifically requested or required by residents as a condition of their consent, forewarning of visits is accommodated. Most often this is a text message or phone call on the day before or day of visits occurring. Advance warning is also established for properties with safety or access restrictions, such as where a dog needs to be contained, or access is via the resident's house or a locked gate. Special accommodations are also made for households with allergies, such as not using peanut butter as a lure.

Declined permissions

Of the properties visited in Miramar, approximately 3% of those spoken to declined to take part in the project. Generally, these were not a major problem as properties were small enough to be 'ring-fenced', with devices placed on neighbouring land to ensure sufficient coverage. We recommend briefly recording all engagement attempts or interactions (for example, where calling cards were left or the reason for decline) in case these properties need to be re-engaged in future.

The most common reasons for not wanting to be part of the project were:

1. Concern for pets on the property,
2. Listened, but declined without giving a reason,
3. Already doing their own trapping or baiting,
4. Refused to listen, no opportunity to explain the project,
5. Believed they had no rats/mustelids on the property,
6. Concern for children on the property,
7. Privacy/didn't want someone coming on the property every week,
8. Ethical reasons,
9. Didn't speak English,
10. Didn't want toxin used on the property,
11. Didn't want to harm hedgehogs,
12. Visual impact or space required for a trap.

Targeted communications that pre-emptively resolve or address these concerns may help reduce the rate of decline. Engagement staff received a negative reception at some properties, residents either refusing to answer the door, being blunt, rude or slamming doors. This was mostly believed to be from being mistaken for salespeople or charity collectors. Emphasising the service was free early in the conversation caused people to noticeably relax. Wearing clearly visible branding also helped with early recognition. Mentioning our association with local Council often lent weight and validity to the project, but in a few situations led to more negative associations (for example, refusing permission based on frustrations with the bus service).

Steep escarpments

For multiple properties along steep hillsides or escarpments, access and safety can be improved by establishing horizontal access lines sidling along the hillside. It is beneficial to identify these areas in advance so permissions can be requested for all adjacent properties across the escarpment, with the added provision of installing an access track, and vegetation cutting if required. Trained staff are also able to install fixed ropes to aid access in steep or slippery areas, where authorised by residents.

Biosecurity Act enforcement

If provisions for the project are included under the local Regional Pest Management Strategy, the Biosecurity Act 1993 can be used to enforce certain aspects of eradication work by Authorised Officers. Staff can be certified as Authorised Officers (Officer Delegation D) and given powers under sections 103 (3) and 105, such as the Power of inspection (entry to land), Use of dogs and devices (e.g. bait stations, detection dogs), Power to request information from land occupiers, and the Power to examine organisms. This has been used very sparingly as a last resort option but can facilitate access to private land which might otherwise prevent local eradication from being possible. For example, after repeated attempts to engage a landowner with no response, or for an abandoned property or undeveloped section where no owner can be located.

Social media & communications

We use a range of channels to spread our message:

- **Our website:** This contains project information, sign up forms, news and resources,
- **Social media:** We post regularly on Facebook, Instagram and LinkedIn,
- **Print and broadcast media:** This is mostly radio and newspaper interviews and helps reach a wide audience,
- **Newsletters:** We send quarterly updates to our subscribers,
- **Events:** We attend community fairs and speak at information evenings for many different groups.

In all our messaging our tone is:

- **Transparent:** We're honest about how the project is progressing. We give monthly social media updates and share our wins with the community. We are also upfront about rat incursions. This helps residents understand that they shouldn't see rats in predator free areas; if they do, they can report them to us,
- **Community focused:** We involve the community and explain how a predator free city will benefit them,
- **Outcomes focused:** We aim to talk more about native wildlife than rats and possums. People can see the increased birdlife, and this is more engaging than a photo of a dead rat,
- **Encouraging:** We like our community to share their experiences and animal sightings.

5. Data collection & analysis

Before beginning an eradication, it is important to have robust systems established for data collection, management, and analysis, as well as specialised staff to carry out GIS work. You should also consider what data you want to record – it is better to start by recording more detail and later pare back if needed. More detailed data will allow more useful analysis.

Trap.NZ

PFW uses Trap.NZ to collect and store data (https://trap.nz/). Trap.NZ is a website and phone app which allows you to create projects to record eradication efforts. The Trap.NZ app is used by all PFW staff and volunteers to navigate, display device and property information, and record data. The app shows a map with coloured points for traps, bait stations and monitoring devices, with the ability to submit records on the outcome of each device check. The Trap.NZ website is used to manage devices and visualise data.

Records are added to Trap.NZ every time a bait station or trap is serviced, regardless of the result. Due to the sheer number of chew cards used, chew cards are recorded only when rat presence is detected. Absence records can be inferred from trap and bait station checks if needed, as the chew cards are located nearby and serviced at the same time.

Data recorded on Trap.NZ at each device check:

Bait stations

- Bait remaining (grams)
- Bait removed (grams)
- Bait added (grams)
- Bait type (formulation, toxin, concentration)
- Target species
- Species detected (tick one or multiple species based on evidence observed inside station)
- Notes (observations of interest e.g. rat droppings)
- Time, device code, date & name (automatically recorded)
- Photo, if possible

Traps

- Species caught (species of rat should be specified wherever possible)
- If rat,
    - Sex (Male/Female/Unknown)
    - Life stage (Adult/Juvenile)
    - Notes convention:

        State of decomposition: *crusty / maggots / fresh*

Distinguishing features: *colouring / markings on body*
Necropsied: *yes / too decomposed*
Weight (g): *only if fresh*
Body length (mm):
Tail length (mm):
Tail snip: *yes / no* (for DNA analysis)
Toxin present? *blue organs, pale organs, liver discoloration, bruising*
If female, signs of breeding? *embryos, implantation scars, increased blood vessels, lactating, bald nipples*
If male, signs of breeding? *bald spot on testes*

- Re-lured (yes/no)
- Lure/s
- Photo/s uploaded, if rat caught
- Time, device code, date & name (automatically recorded)

Chew cards

- Disturbed (yes/no)
- Species detected (including determining species of rat, if possible)
- Lure used
- Notes (observations of interest, e.g juvenile rat chew)
- Photo uploaded
- Start and end date of monitoring period

Bait station 'species detected'

When staff enter a bait station record into the Trap.nz app, they select the 'species detected' field to record which species they believe may have eaten the bait. Inspecting bait stations for evidence of animal sign (such as chew marks, footprints or droppings) can be very subjective, and assessments of rat presence often vary in their level of confidence depending on the information available. To reduce the chance of 'false positives' (recording rat presence where there wasn't any) or 'false negatives' (failing to record rat presence), we divide these assessments of rat presence into two categories, added to Trap.nz:

- **'Rat - Confident'**: reasonably confident that there has been rat presence, based on some tangible evidence inside the bait station (e.g. droppings, chew marks or footprints).
- **'Rat - Possible'**: suspected rat presence, but with a lower level of confidence. May have no tangible evidence inside the bait station, but something to indicate possible rat presence, such as a rat detection on a chew card nearby, and bait missing from the station.

These assessments are differentiated from other 'species detected' categories:

- **‘Unknown’**: Some animal evidence in the bait station, but unable to confidently identify it to a species (e.g. unidentifiable chew marks).
- **‘None’**: Bait has been taken, but there is no evidence present to determine what species may have taken it.

Multiple species are able to be selected, so it’s possible to have several recorded in one station (e.g. ‘mouse’, ‘mollusc’, and ‘Rat - Possible’). These different categories allow us to vary the weighting placed on potential rat detections and adjust our response accordingly.

ArcGIS® Pro

PFW uses ArcGIS® Pro (ESRI, https://www.esri.com/en-us/arcgis/products/arcgis-pro) to view and analyse our device networks and data daily. An API data feed can be set up to view Trap.NZ data and information in ArcGIS® Pro. You can filter data, customise symbology, layer information together, generate maps and analyse and report on data, providing a much more detailed and customisable experience than the Trap.NZ website allows.

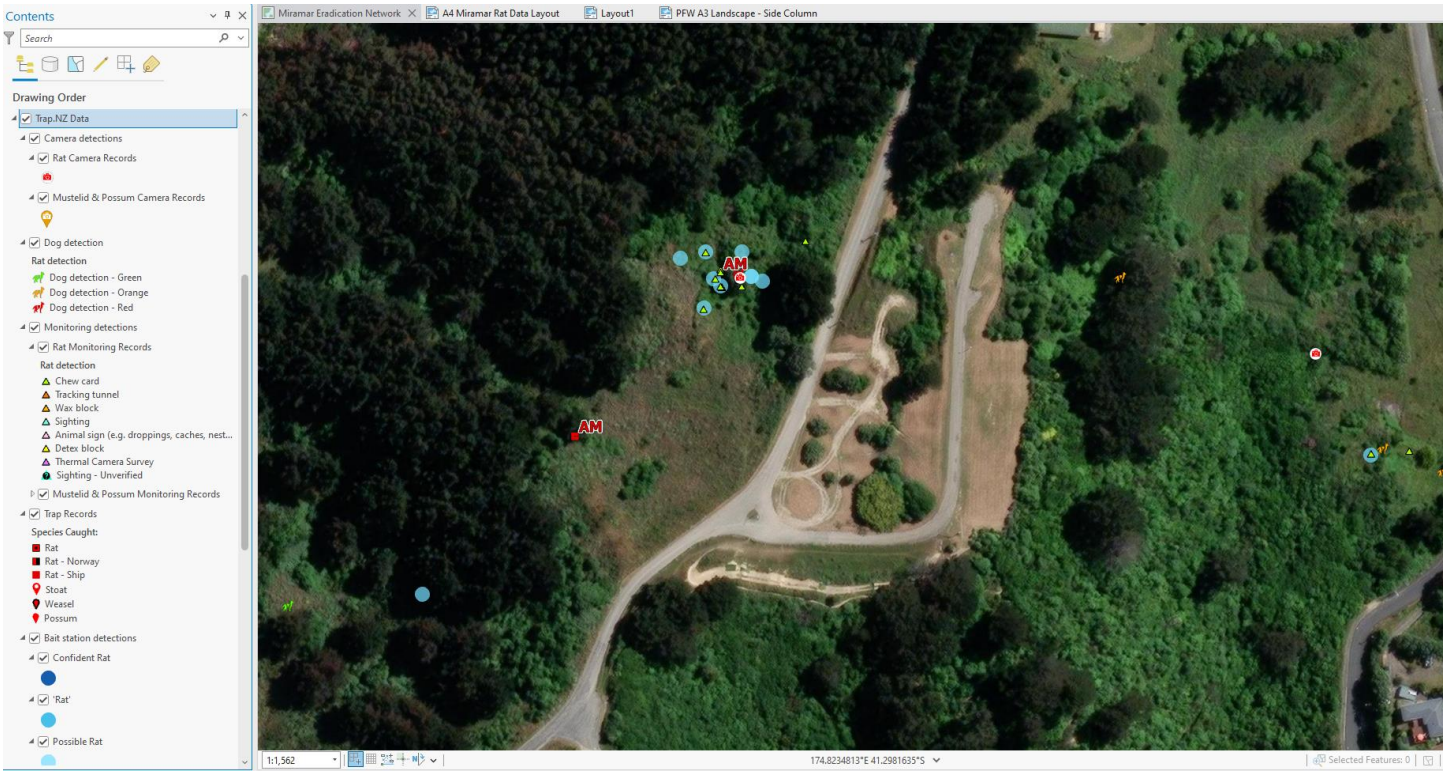

Figure 5: *Layering data sources using ArcGIS® Pro to build a picture of rat activity.*

Trail camera data

Trail camera images are generally processed manually on a computer. Although we’ve trialled some AI image software, none have yet proven reliable enough to confidently trust with identifying images by species. MegaDetector software has been used to separate images with no animals present in instances where there are large number of images recorded on a camera

(https://github.com/agentmorris/MegaDetector). Camera monitoring points are created in Trap.NZ for each trail camera location. Camera images can then be uploaded to these points, and the outcome of any detections recorded.

Data analysis

ArcGIS® Pro is used to compile and visualise all data sources and generate maps and statistics. Field data is reviewed every morning from the previous day and vetted for accuracy and quality. Following completion of servicing an area, data is viewed and discussed. The level and distribution of target species activity triggers changes or actions for the next visit, which are communicated to Field Supervisors. A Microsoft Excel spreadsheet is used to track key dates, activity and efforts in each work area. These can then be used to inform modelling or predictions for future areas with improved accuracy. Key metrics are tracked to document project progress, such as the number of devices serviced and number of detections within each zone. Fortnightly reports are generated to inform staff, volunteers and stakeholders of project progress.

6. Carrying out an urban eradication programme

Project planning

Target species

The PFW method described in the sections below focuses largely on rats, due to their abundance and difficulty to eradicate. It assumes most weasels and stoats are successfully removed through secondary poisoning. The trap network outlined below is designed to catch any remaining stoats or weasels. Extensive monitoring through trail cameras and mustelid dog detection surveys indicates our method has been successful for mustelids, as well as rats.

Devices used by PFW

Tools	Core devices	Supplementary devices
Traps	- BT200 (DOC200 equivalent) trap in wooden box, weka length entrances (to prevent cats reaching mechanism)	- Victor Professional Rat Trap - T-Rex Rat Trap
Bait stations	- PelGar Rat Station (lockable bait box) - ZIP Lola Bait Tunnel	- Corflute tunnel - Novacoil tunnel (flexible 100mm drainage pipe) - KK (collapsible tree mounted bait station) - Protecta Sidekick
Toxicants	- Pestoff Rodent Pellets - Pestoff Rodent Blocks - RatAbate Strikers (diphacinone)	- RatAbate paste
Lures	- Fix & Fogg Peanut Butter - Best Foods™ Real Mayonnaise - goodnature® Meat Lovers Pre-Feed Paste - ZIP MotoLure	
Monitoring	- Chew cards: Custom printed chew card (45x90mm, non-folded. Wakefields Digital, wakefields.co.nz)	- Waxtags - Tracking tunnels - DETEX BLOX With Lumitrack (glows under black light)

- Trail cameras: Browning Spec Ops Elite, Dark Ops Pro, Command Ops Elite.

BT200 Double-set trap box

Tree-mounted T-Rex in corflute shroud

Victor trap in corflute box

PelGar Rat Station secured with metal pins and elastic cord.

Inside PeGar with pellet bait

KK bait station

Novacoil tunnel

ZIP Lola tunnel

Chew card

A trail camera facing a MotoLure.

Example of a trail camera field of view, showing a chew card attached to a tree to provide scale.

Trail cameras

We have trialled several different trail camera models, but for the most part use the following:

- Browning Dark Ops Pro DCL (BTC-6DCL)
- Browning Spec Ops Elite (BTC-8E-HP5)
- Browning Command Ops Elite 22 (BTC-4E22)

These models still have some drawbacks but have generally performed well. Cameras are usually mounted to wooden stakes, 20-30 cm off the ground, and secured with a strap or cable ties. About 1.5 to 2 metres away, in view of the camera, a ZIP MotoLure is secured to a wooden stake (https://zip.org.nz/products-list/motolure). This automatically dispenses a small volume of egg mayonnaise once per day, providing a fresh and consistent lure to draw animals into view. Vegetation that may trigger the camera is cleared from within view. An unfilled chew card is placed part-way between the motolure and camera to provide scale and help discern rats from mice in images.

For screenless camera models, an SD card to phone adaptor can be used to check the field of view at installation. Both trail cameras and MotoLures are checked at least once per month, to ensure battery levels and functionality, and to process captured images. The camera settings we apply are aimed at balancing probability of detection, battery longevity and the quantity of images captured and consequent processing time required. Video recording is only used in select situations where a greater understanding of animal behaviour is desired.

PFW trail camera settings:

- *Operation Mode:* Trail
- *Photo Quality:* Medium (4 or 8 MP)
- *Video Quality:* High
- *Video Length:* 10 Secs
- *Picture Delay:* 20 Sec or Off
- *Multi Shot Mode:* Off
- *HDR:* Off
- *Temp Unit:* Celsius
- *Image Data Strip:* On
- *Motion Detect:* 60 Ft Range OR Normal Range
- *Battery Type:* Alkaline
- *Trigger Speed:* Normal
- *Default Settings:* No
- *Timelapse Freq:* 1 Min
- *Timelapse Period:* All Day
- *Smart IR Video:* Off
- *Sd Management:* Off
- *Delete All:* No
- *IR Flash Power:* Economy
- *Capture Timer:* Off
- *SW or FW Upgrade:* No

Device placement

A grid can be used to help plan your network of traps and bait stations. Initial planning will overlay a proposed grid of 50m x 50m bait stations for rats, and 100m x 100m traps for mustelids. However, the grid is only a starting point to ensure consistent coverage over an area – we then make adjustments to account for the environment. In most urban areas, a 50m x 50m grid won't be sufficient to achieve zero rats. Rat numbers aren't uniform across a landscape – they will be higher in favourable habitat and lower in poor quality habitat. Based on this we can optimise rat eradication by intensifying our device density in areas with high rat activity and reducing it in areas of low rat activity.

Firstly, the grid spacing must be adjusted based on the predominant habitat type, as habitat is used as a predictor of rat numbers. In habitats with typically low rat activity, a 50m x 50m bait station network might be sufficient. In habitats with moderate activity, a higher density of devices might be required, either a smaller starting grid (30-40 metres), or using a 50 m grid but selectively adding additional devices in between in areas of favourable rat habitat. In habitats with typically high rat activity, we recommend reducing bait station spacing to 25 x 25 metres. The trap network is adjusted accordingly, to double the bait station distance, so 1 out of 4 bait stations has a trap located with it.

Secondly, we must account for contours. Grid networks are typically created on a 2D 'birds-eye' plane, which doesn't account for hills and variation in elevation. The 3D landscape means that actual ground distance between devices is often further than the planned distance. You should adjust your grid spacing to account for this if you are working in steep terrain.

Thirdly, we must account for microhabitat, and make sure we target the areas where rats will be. This will make eradication efforts more effective and efficient. We adjust the final location of each grid point when deciding where to place the device, scouting for rat-favoured microhabitats such as dense vegetation. This is usually best done by field staff upon installing devices, but to some extent can be done as a desktop analysis using GIS tools. Dog detection in advance is another great way to guide placement of devices. It's more important to target good habitat than to stick to your pre-defined grid spacing – shifting the device 10 metres or more could be the difference between detecting a rat and not. A device placed in poor rat habitat is often a waste of time and resources.

Fourthly, we 'infill'. 'Infilling' is a term we use to describe adding additional devices in between the baseline grid points. This allows us to intensify the network in areas we predict will have high rat numbers, such as good habitat, microhabitat or around substantial food sources. Infilling is an important part of building a habitat specific elimination network.

Finally, device locations are influenced by on-the-ground factors such as property access permissions and accessibility. The arbitrary placement of planned points will often rely on landowner permission, so point locations will be further refined as property permissions are gained. Adjustments to the network are made at the desktop planning stage, during the permission gathering process and when field work commences, resulting in the final network.

Operational challenges

Weather

Weather has caused regular challenges, both for our team and equipment. For example, trail cameras and bait need to be kept dry while servicing. It is helpful to have good wet weather gear, an effective drying room, the ability to take shelter in vehicles when required, and having a few indoor jobs in the back pocket (such as processing trail camera images).

Planning the week around the weather forecast is also worthwhile, for example avoiding stands of old pines on days of forecasted high winds, where there's a risk of branches falling. During severe storms

with high sea swells, bait stations or traps have been swept out to sea. When high swells are forecast, devices are now moved or secured, with bait pre-emptively removed from bait stations along exposed areas of coastline.

Cliffs

Cliff faces have been a significant challenge where they are too steep to safely traverse on foot. This leads to gaps in the device network. We're yet to come up with a perfect solution but have had success with a few methods:

- Installing fixed ropes as a hand holds to make access safer in steep places
- Installing trail cameras as close to cliffs as possible so we can monitor for activity
- 'Ring-fencing' cliffs with devices at close spacing around the edges
- Suspending devices on ropes and lowering down the cliff face (easier with sparse vegetation)
- Surveying using a thermal scope at night (with mixed success)

Drones or abseil access have been considered but not required to date.

Human challenges

Vandalism is relatively rare, but in most cases damaged traps and bait stations are those highly visible to the public. Theft has been an issue primarily for trail cameras, again in highly visible areas. We aim to place stations discreetly so they are out of sight of the public where possible. Trail cameras are engraved with "PFW" and our 0800 number to try and deter theft for resale.

Some properties have presented challenges, such as people on home detention, gang activity or rubbish hoarding. In each case the risks and possible solutions are weighed. Higher risk areas are serviced by pairs of staff working together. In select cases where residents do not want Predator Free Wellington staff on the premises, we have been able to arrange servicing by a volunteer from the community who they know and trust.

In cases of rubbish hoarding, we explain the risk food waste and refuse pose to the project and work with the resident to arrange proper disposal. Commercial or household rubbish dumping has been an issue along roadsides and reserve edges, including asbestos containing materials. We've sought media exposure to educate the public on the need to minimise available food waste for rats, and to report these events to us when encountered. We held a community rubbish cleanup event before starting our eradication in one particularly rubbishy section of bush reserve.

Dogs have been one of our most significant risks and safety challenges. Staff have encountered aggressive dogs off lead in public spaces, and on private properties. We've established a good relationship with Animal Control Services and can contact them for unattended dogs in public areas. Animal Control Services also train our staff on dog safety and awareness. Properties with aggressive dogs are generally marked as a hazard and avoided, unless an arrangement can be reached with the owner to visit at a time the dog is not there or is contained. For every dog on a private property we record

information on its size, location, temperament, breed and description on Trap.NZ, so staff can be informed on what to expect.

Unplanned events have included scrub fire, construction sites, pandemic lockdowns, government protestors and road closures which all impeded access. In most cases these just required time and patience. Thankfully, we have not had issues with vocal protestors or objectors to date.

The PFW eradication process:

The eradication process is carried out over areas of approximately 40 hectares at a time, known as 'Zones'. Several zones may be active at once, each at different stages along the eradication process.

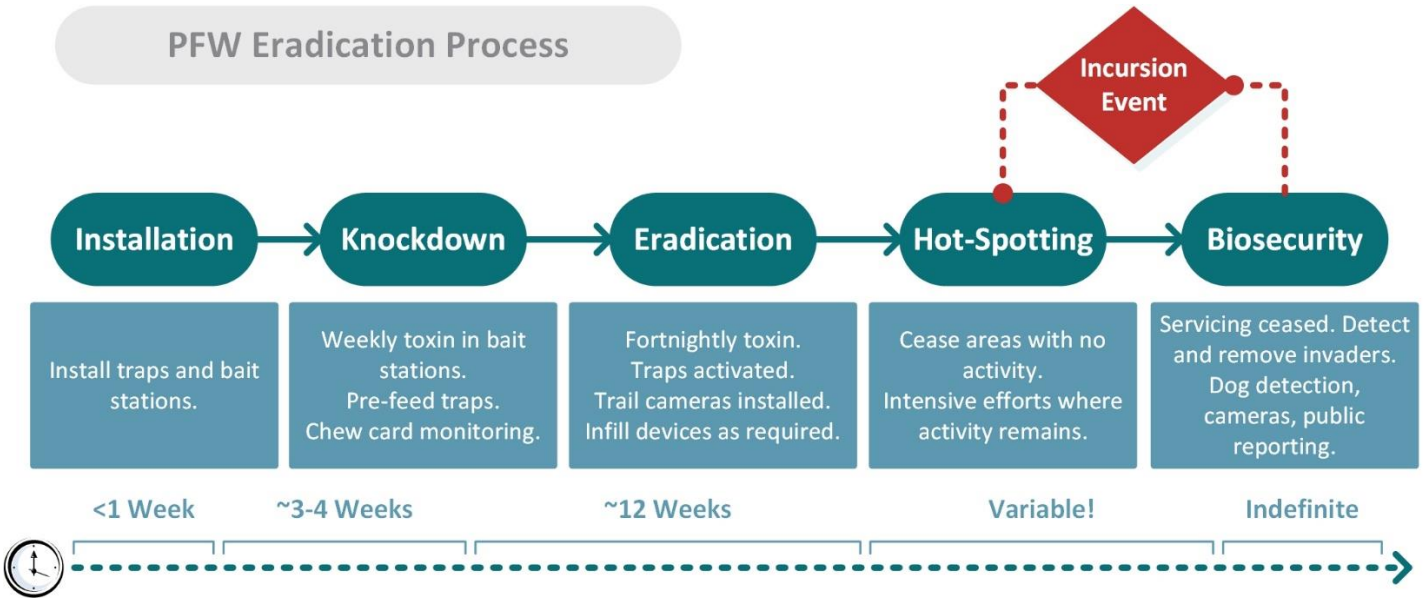

Figure 6: *PFW Eradication Process overview*

1. Installation

The installation phase involves establishing the bait station and trap network. Staff use device locations, property permissions and notes stored in the Trap.NZ app to install devices. When moving into a new area, staff must be vigilant of new potential hazards, such as dogs, rubbish, ACM (asbestos containing materials) or aggressive people.

When installing a device on private property, staff abide by any instructions and special requirements noted on Trap.NZ. Unless residents have requested a specific location for their device, the section is inspected and the best location chosen where there is likely to be rat presence. Locations with good microhabitat (e.g. compost bins, wood piles, dense vegetation or preferred plant species) are usually

chosen. Staff will also inspect the property for signs of rat presence, such as droppings, burrows or chew marks.

On public land like reserves, berms or coastlines, habitat and rat evidence are also considered for device locations, as well as public safety. Where possible, devices are installed in places that are less visible, to reduce the chance of tampering, and kept several metres away from public tracks to reduce risks to pets and people.

Once the zone is fully installed, the Knockdown phase begins.

2. Knockdown

The knockdown phase aims to remove the majority of the rat and mustelid population. During this phase, all bait stations and traps are serviced weekly. This allows sufficient time for rats who have consumed toxin to die off, before we return and rebait, and also ensures an effective compromise between bait freshness, toxin availability and optimal use of staff time.

Traps are initially disabled and lured, or 'pre-fed,' to get animals comfortable entering the trap box, and create scent trails to draw in others. To disable the trap, the mechanism is cable-tied open and the metal plate screwed down to the base of the trap box.

Bait stations are baited with Pestoff Rodent Pellets wherever safety allows, these have the best interaction rates by rats. Where dogs, children or members of the public have easy access to stations, Pestoff Rodent Blocks are used instead, secured inside the station using steel pins or wire. At each visit, bait stations are completely emptied of bait, insects, animal evidence and debris, and fresh bait is added. 100 grams of bait is added by default each visit, however if most or all of the bait has been eaten, 200 grams is added. Conversely if all of the bait remains untouched from the last visit, the quantity can be reduced to 50 grams. The team inspect bait stations for evidence of what may have eaten bait, looking for droppings, tooth marks or footprints. This is recorded on Trap.NZ.

A peanut-butter lured chew card is placed near every bait station and trap and is replaced at each visit. These have been very effective at detecting rat presence.

Weekly services are repeated until bait consumption and evidence of rats have both reduced noticeably. This has typically taken 3-4 weeks but varied between three and seven weeks depending on habitat and other factors. After this, the whole zone is moved into the Eradication phase.

3. Eradication

The eradication phase aims to remove any remaining rats and mustelids. During the Eradication phase all bait stations and traps are generally serviced fortnightly. The eradication phase is more complex, with a few additional stages within it.

Traps are activated during this phase. As traps are primarily targeting any remaining mustelids and bait-shy rats, we want to allow sufficient time for the bulk of the rat population to have died out by toxin.

Opening the traps any earlier would likely mean trapping animals which have already consumed a lethal dose of toxin, effectively killing them twice, and wasting effort.

Traps are initially set at a trigger weight around 80 grams, to catch stoats and rats. After several services with the traps activated, traps are then calibrated to a lower trigger weight of around 50 grams. This allows us to catch any remaining weasels who may have been too light to trigger the trap previously. Had we reduced the trigger weight to begin with, it may have been too sensitive for larger animals such as stoats and led to the creation of trap-shy animals.

Early in the eradication phase we perform a 'gap-analysis'. This is a visual inspection of the device network (both computer-based using ArcGIS® Pro and assessing in the field) to see if there are any areas we haven't checked for rat presence. Places that are investigated are typically areas of 25m x 25m or greater with no devices, isolated pockets of good rat habitat, risk points such as compost bins where rats may have a small home-range, or steep slopes where the actual ground distance between devices is greater. We endeavour to test these gaps with monitoring devices (such as chew cards) at a minimum, to make sure we have comprehensive coverage of an area and no populations go undetected. Additional bait stations are added where necessary; we call this process 'infilling'.

As bait take and rat detections decline to very low levels, trail cameras are installed at a density of one per hectare. Trail cameras are our most sensitive and passive monitoring tool (the animal doesn't have to interact with the device) and allow us to detect any neophobic animals that have failed to interact with our chew cards, bait stations or traps. Trail cameras are installed at ground level, facing a ZIP MotoLure (https://zip.org.nz/products-list/motolure). The MotoLure automatically dispenses mayonnaise once a day, providing a fresh, consistent lure to bring animals into the field of view.

As another layer of detection, ideal for inspecting areas between our devices, dog detection surveys are used to find remaining rats. An experienced dog-handler team has been crucial to locating rat nests, dens, caches and runs which can then be targeted by installing additional lethal devices.

The length of the eradication phase can vary greatly depending on habitat and other factors. On average, it has typically lasted us 6 fortnightly services (or 12 weeks).

4. Hot-spotting

The purpose of the Hot-spotting phase is to 'close' parts of the zone registering zero activity and focus extra attention on any areas with remaining rats. The zone is no longer treated as a whole, but instead becomes a mosaic of active and inactive areas for the final effort to reach zero rats. The biggest challenge in this phase can be finding the 'goldilocks' zone: putting in enough effort to achieve eradication without wasting unnecessary time and resource where it's not needed.

Data analysis is a crucial part of the Hot-spotting phase. Rat detections recorded across chew cards, trail cameras, bait stations, traps and dog surveys are compiled and visualised using ArcGIS® Pro. Each instance of reported rat activity is investigated and scrutinised to ensure accuracy and build a picture of what is going on in the area. Any areas which have registered zero rat activity for at least three services

(six weeks) can be ‘retired’. Retiring an area involves ceasing the servicing of bait stations, traps and chew cards, but keeping the trail camera network active.

Trail cameras are checked monthly to monitor for any rat presence – either previously undetected animals left behind, or rats reinvading from surrounding areas. Lethal devices are left in place to allow for a fast response if a rat is detected again within a retired area. These retired areas are declared locally eradicated, and moved into the next phase, Biosecurity.

The remaining areas still registering rat activity are regarded as ‘Hot-spots’ and are each managed on an individual basis. Methods are tailored to that specific zone to remove remaining rats. Actions that may take place in a Hot-spot are:

- Increasing or decreasing the servicing frequency,
- *Infilling*: Installing extra devices in response to network gaps or high activity,
- Moving devices to better locations,
- *Bait-switching*: alternative lures for traps, or an alternative toxin (such as diphacinone) to account for potential bait-aversion or individual taste preferences,
- *Device-switching*: swapping devices for different ones (e.g. a closed bait box to a more open tunnel) or adding a greater variety of device types (e.g. addition of a T-Rex trap next to a bait station),
- Using dog detection surveys to hone in on remaining rats,
- Installing additional trail cameras to observe the rat’s behaviour and understand why it may not be interacting with devices.

Hot-spots are reevaluated after every service to assess what further actions are needed, or if the size or shape of the area should be adjusted. Hot-spots are retired one-by-one until the entire zone is eventually placed into the Biosecurity phase. Time spent in the Hot-spotting phase can vary widely, but each new area retired frees up staff resource which can be moved into starting the next zone.

5. Biosecurity

The Biosecurity phase is the last stage in the eradication process. Areas in the Biosecurity phase are declared eradicated, but vigilance and monitoring must be maintained as incursions can happen at any time.

Dog detection

Having a rat detection dog and handler has been highly valuable to eradicating rats in an urban environment; the task would be a lot more difficult without this resource. It’s also a big timesaver by being able to accurately locate rats or check public sightings quickly, without the labour of installing monitoring devices and returning to check them. It’s been beneficial at every stage in the process:

- In the Installation phase, guiding where bait stations and traps are placed, by locating rat runs or dens,

- In the Eradication phase, locating rats that fall in gaps between the device network,
- In the Hot-spotting phase, to confirm that areas registering zero rat activity can be retired,
- In the Biosecurity phase, to investigate potential rat sightings or routinely survey incursion risk areas.

The dog handler generally goes door-to-door requesting permission to survey each property, unless prior permission has been granted. The Biosecurity Act has been used sparingly to gain access to properties. A detection dog is a great advocacy tool – people have generally responded well to meeting them, and access is granted in most cases. It's also a good option for properties opposed to toxin or trap use, to establish whether rats are present and help facilitate conversation.

A challenge with dog detection has been weather dependency – strong winds or rain make scent difficult to detect, so surveys are generally restricted to good weather. Old carcasses can also last for some time in the environment (especially in dry enclosed areas such as roof spaces) and this can lead to 'false positives'.

To record dog detections, we use a traffic light system where the handler interprets dog behaviour:

- Red detection: High confidence of rat presence, believed to be a live rat present either currently or recently. Often a strong indication on a precise spot.
- Orange detection: Moderate confidence of recent rat presence. May display as general interest or tracking in an area.
- Green detection: A weak indication of low confidence. May show interest in scent on the wind, vague interest in an area or be interpreted as likely a dead carcass or older scent.

We usually respond to a red or orange detection, but generally gather more evidence before responding to a green detection. Detection dogs occasionally miss things, or their indications can be misinterpreted, meaning they are not always accurate. They provide another valuable layer of evidence that can be used for decision making.

Best-practice tips for eradicating rats

One bad interaction can put an animal off entering your devices for good, so every set counts when it comes to eradication. Taking the time to present devices well can save time in the long run, if it means animals are willing to interact more quickly. Here are a few tips and tricks we've found successful:

Use what they like

- For difficult to catch rats, take advantage of what you know they like or are comfortable interacting with. For example, if you have a rat chewing peanut butter corflute chew cards but it won't enter a trap in a wooden box, try creating an alternative trap shroud from corflute and luring it with peanut butter. This uses materials to your advantage and the rat might become attracted to the trap.

Make it natural

- Blending devices to their surroundings may make them less intimidating to neophobic animals. A layer of dirt or leaf litter across the floor of the device can make the contrast with the surrounding environment less stark.
- Depending on the environment, rocks or vegetation can be built up around the device to help it blend in.
- Allow a bit of time for devices to 'weather' in the environment, so unfamiliar scents aren't so strong.

Creating a more natural floor in a bait tunnel.

Spruce up your entrances

- Making entrances as wide as safely possible (to still exclude non-target species) will increase animals' willingness to enter.
- Make sure entrances are free of sharp edges – any metal snags should be filed down.
- You can also move dirt to make the ground level with the entrance, so a large step up or down isn't required.
- Scuff up dirt at the entrances and leading up to devices – this creates lots of fresh scent and gives the appearance of a well-used pathway.

Make it stable

- The claw of your hammer can be used to level the ground under your device. If it wobbles when an animal steps foot in the entrance, it may be deterred.
- Various methods can be used to weigh down or secure devices to the ground. This helps reduce movement and adds an extra layer of security.
- Avoid having your device sloping on an angle if possible. If it must be sloping, place the entrance on the downhill side, so animals climb uphill into the device.

Pre-feed

- A small amount of lure used strategically around the device can create interest. A swipe of lure in the entrance, or in the environment nearby, can create scent to draw animals in and gives them a small taste so they seek out more.

Think in 3D

- Rats move differently through the environment to us. Norway rats burrow and ship rats are excellent climbers – their favourite movement pathways might not be along the ground.
- For ship rats, consider mounting devices on angled tree branches which provide a clear run to the canopy, especially fruiting trees.
- Bait or traps can be mounted directly to stakes or wires and inserted into burrows actively used by Norway rats.

A tree-mounted rat trap.

Select your bait wisely

- Not all toxins or formulations are equal when it comes to rats' willingness to eat them.
- Wherever safe to do so, use toxin in pellet formulation over fixed blocks. Rats like being able to carry bait away to eat somewhere safe, or cache for later.
- Avoid baits with added bittering agents (e.g. Bitrex®).
- Our most successful bait has been Pestoff Rodent Pellets. RatAbate Diphacinone Strikers or paste have also been effective but require a rat to consume more for a lethal dose. Pestoff Rodent Blocks have also been successful, but pellets are preferable, so blocks are only used where safety requires. FINAL All-Weather BLOX (Bell Laboratories) are the least successful bait we've trialled.

Use toxin as your main eradication tool, and traps to supplement

- Traps are great for providing information on the species, age and sex of rats in an area, but they are often single-kill devices which require resetting and rebaiting to catch again. We also believe they have lower interaction rates – not all rats will interact with a trap.
- Toxins provide the ability to kill multiple rats with one visit to a device, meaning your effort goes further. As they're a food source they also allow the creation of pheromone scent trails, which can lead other rats to investigate.

Make it easy for them

- We want to minimise how much we're asking of the animal. The more barriers and complexity, the less likely they will interact with a device.
- Make sure there is clear and easy access to the device. Vegetation cover overhead is good, but thick long grass surrounding the device will make it harder to get to.
- A run-through style device with a clear line of sight works best, especially if they can see the lure from the entrance.

Keep it varied

- We're yet to find a one-size-fits-all solution for removing rats, they're individuals with varied preferences and behaviours. Provide some variety in your devices and how they're presented and rotate different lures occasionally.

7. Biosecurity: monitoring success and managing incursions

While it's difficult to 'prove' you've reached eradication, the combination of data obtained from dog detection, chew cards, trail cameras, bait stations, traps and public sightings over multiple weeks of repeat visits, together form a good body of evidence that you have achieved 'proof of freedom'. In other words, all our different layers of detection provide sufficient evidence and confidence that it's unlikely a breeding population of rats remains.

PFW has a dedicated team who maintain Biosecurity areas, called the Capture Team. Within Biosecurity areas, the Capture Team is tasked with:

- Maintaining the trail camera network,
- Investigating potential rat sightings or dog detections,
- Responding to incursions and servicing Hot-spots.

Incursion detection

We have three layers of Biosecurity monitoring to enable us to detect incursions: trail cameras, dog detection and community reporting. Individual rats may occasionally slip through undetected, but if a breeding event occurs, this method has so far been robust at detecting it.

Trail cameras

Following eradication, trail cameras are initially placed at a density of one per hectare, and later reduced to one per five hectares once we are confident the incursion risk is low, and no rats remain. This may not be dense enough to pick up every invading individual but will detect breeding populations if they occur. Staff visit trail cameras on a 3-4 weekly rotation, or more frequently if activity is detected. Camera images are checked for our target species, with detections recorded in Trap.nz.

Community reporting

The community provides an invaluable resource for detecting rat invaders as our constant eyes and ears on the ground. There are several avenues for members of the public to report potential rat sightings or activity. These include an online form on the PFW website (https://www.pfw.org.nz/our-project/contact-us/), an 0800 phone number, an email address and social media messaging. We take all rat sightings seriously, and unless they can be immediately nullified (e.g. by identifying a photo as a mouse), we endeavour to respond within 24 hours.

Dog detection

Periodic dog detection surveys are conducted to check areas remain rat-free. Incursion risk-points are identified as sites with a higher likelihood of rats arriving via vehicles, dumped rubbish,

large deliveries of goods, over ground or via water. For PFW these have included areas such as bus depots, airports, public carparks, marinas, coastlines, industrial areas and shopping centres. These sites are surveyed monthly.

In addition, ad hoc surveys are conducted across broader areas as time allows, to ensure they remain rat-free. Dog detection is frequently used to verify (or rule out) community rat sightings.

Incursion response

An incursion is not reason to panic: the same methodology used to eradicate can be applied again to remove invaders. There is no one-size-fits-all response to incursions. They're generally assessed on a case-by-case basis and treated very similar to a Hot-spot during eradication.

Information gathering is generally the first step. Depending on the initial detection, this may involve monitoring (cameras, chew cards or dog detection) alone, or in combination with reactivating traps and bait stations. Critical questions to answer are:

Is it definitely a rat we've detected?

- Members of the public often misidentify mice or other animals as rats. Identifying rat droppings from those of mice, wētā or lizards can also be a challenge.

Is it still alive?

- Dog detection may pick up long-dead rat carcasses, or an invading rat may have already encountered a trap or bait station.

Is it still in this location, or has it moved on already?

- A dispersing rat may travel several hundred metres or more, and a single rat image on a trail camera might not be worth responding to if there's no evidence the rat is sticking around.

Is this a lone rat, or a population?

- A male rat poses limited risk on his own. Staff time is valuable, and it's worth considering what the worst-case scenario might be if you do nothing at all – sometimes this is the best course of action.
- Evidence of multiple rats will require a more rapid and involved response.

Incursion management

If you've verified there are live rat/s present, and determined a response is necessary, the next step is usually to 'liven' the network: re-engage with residents, service traps and bait stations and place out monitoring over a wider area. Dog detection is brilliant at determining how wide to cast the net.

If evidence of breeding is detected (e.g. catching a juvenile rat) it's worth covering a wider area: young rats will disperse to find their own territories. Servicing weekly is recommended, at least to begin with, to ensure bait is kept available. If mice populations are high, they may take large volumes of bait initially.

Response areas are treated much like Hot-spots, where the data is critically assessed after every visit and the servicing frequency, area and regime adjusted accordingly.

Virtual buffer

The nature of a rolling front approach means there is always a leading edge which is vulnerable to incursions over land. Once areas are eradicated it's crucial to protect them from reinvasion from adjoining areas where rats are still present. In an urban area, a physical boundary such as a predator-proof fence is generally impractical, plus the boundary is constantly moving as the project progresses.

The system we use is called a 'virtual buffer'. This is a zone of predator suppression which is actively baited and trapped along the leading edge of the operational area. Devices are generally serviced at least monthly throughout this buffer zone. Open, exposed areas of poor rat habitat make the best buffers as animals are less likely to move through them – features such as sports fields, airports, water bodies or large roads can be used to your advantage. Pasture or stands of exotic pine can also be used.

For the purposes of defending from rat incursion, a buffer area should be a minimum of 200 metres deep from your leading edge, with the entire eradication network within it kept 'live'. A 200-metre-wide buffer will still likely see some rats make it through, depending on the terrain and the level of rat pressure on the outside edge. A wider buffer (300-1000 metres deep) will be more effective at repelling incursions but will take more staff labour to service.

A balance should be found between the time and resource required to service a buffer, and the rate of incursion. Occasional rat invaders that make it through the buffer should be detectable by public reports, trail cameras or dog detection, but the labour to detect and remove these incursions (reactive defence) shouldn't outweigh the effort to maintain a wider buffer (proactive defence).

We've found coastlines with beaches, dunes or boulder banks to be movement highways, particularly for Norway rats, and are one of the most common routes of incursion. For buffer zones that include coastline, we recommend extending the buffer area in a narrow band along the coast. Depending on the site, a coastline extension of 700 metres or more ahead of the buffer, and an additional 700 metres behind the leading edge, has helped to noticeably reduce reinvasion pressure.

We haven't been able to gain sufficient evidence on an effective buffer for mustelids. Given how far they can disperse, it is likely impractical to maintain a buffer of a size that would be effective for mustelids. We've found that focusing efforts on broad scale monitoring (via trail cameras and routine dog detection sweeps) has been the most cost-effective. Mustelid incursion events have been rare, so a reactive approach to incursions was the best option for us.

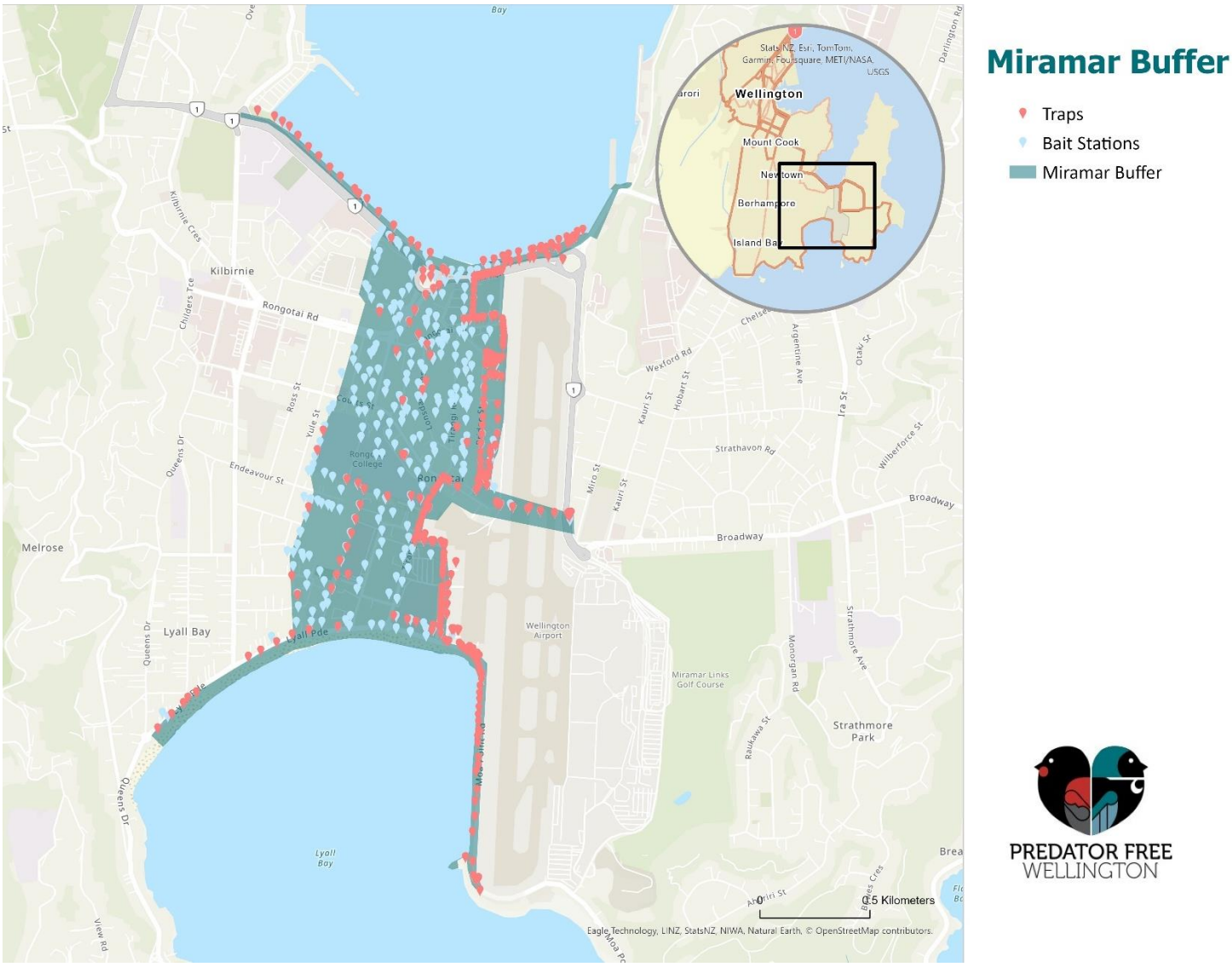

Figure 7: *Map of the Miramar Buffer system, showing the network of bait stations and traps to reduce reinvasion pressure from the west.*

Mustelid biosecurity

Stoats and weasels pose different challenges to rats when it comes to biosecurity. As they travel rapidly over much greater distances, the response must be strategic so that time is not wasted where the animal may have already moved on. In a large mainland area, some patience may be required for a dispersing mustelid to establish a territory, and for us to understand where it is spending most of its time so it can be effectively targeted.

Detection

Valuable tools in detecting urban mustelids are trail cameras, public sightings and dog detection. The trail camera network described above for rats has also been effective at detecting stoat presence. Trail cameras can be further optimised for mustelids by positioning them high and with

a wider field of view, especially at saddles in the landscape. Analysis of trail camera images may provide information on the number or sex of invaders.

We have routinely scheduled six-monthly mustelid dog detection surveys, particularly of the coastline and bush reserve areas. During an incursion, dog detection can be used to gain additional information on an invader's use of the landscape, for example identifying dens or play sites. Publicising incursion events, and advocating for public sightings to be reported, is another valuable tool worth utilising in urban areas.

Response

To remove invading mustelids, we use BT200 traps and may do pulses of brodifacoum to provide secondary toxin via rodents. Holden live capture tunnels were also recommended to us by other projects. Big chunks of fresh meat (e.g. rabbit, venison) and mustelid scent (e.g. from bedding material) make good lures. Where feasible, volunteers are a hugely valuable asset. Empowering and resourcing them to manage an incursion response can drastically reduce the expense of dealing with an incursion.

Our stoat incursion events

We have had two documented stoat incursions to Miramar. The first event was detected across three camera images and two sightings between March and November 2022 over an area of 11 hectares, with an additional sighting six kilometres north. After this it was not detected again and presumed dead or moved out of the area. The second event was detected across 13 camera images, four public sightings and two dog detections between December 2023 and July 2024, over an area of 500 hectares.

Our images indicated we were probably dealing with one adult male. A team of skilled and dedicated volunteers led the majority of the response, collecting and processing camera images and servicing traps. The most effective method was to focus on quality over quantity, maintaining a small number of very well-set devices, rather than many suboptimal ones. The stoat was eventually caught by volunteers in a double-set BT200 trap in a run-through wooden box. The trap had recently been repositioned and optimised so it was stable with entrances filed down smooth, and lured with stoat bedding material and venison meat in sight of the entrance. The stoat captured was a young (<1 year old) male, which had likely recently dispersed to find its own territory.

8. Staff management

Staff recruitment

Prioritise hiring staff with the right attitude and ability to adapt to change at short notice. Field skills can be taught, and traits such as resilience, positivity and critical thinking will be more beneficial to eradication projects, in the long term. Recruiting for good team-fit and a positive workplace culture will increase staff retention and morale.

PFW team structure

Project Director (1 Full-Time Employee): High level project direction & strategy, partnerships, board & stakeholder reporting. Responsible for bringing all workstreams together: comms and engagement, partnerships, operations and community. Responsible for the entire project budget and external relationships.

Project Leader (1 FTE): Operational staff and contract management, recruitment, finances, procurement, oversight of operational activities including technical decisions, community work and link with partners.

Operational Lead (1 FTE): Operational leadership and technical decision-making, manager to Field Supervisors.

Partnerships & Philanthropy (1 FTE): Funding, event management, project partnerships and stakeholder relationships.

Communications Manager (1 Part-time): Communications strategy and implementation; media releases, social media and external communications.

Communications Programme Lead (1 FTE): Community relationships, event management, volunteer and project support, website & social media maintenance.

Eradication Technical Officer (3 FTE): Data management, mapping and analysis, planning, systems development, technical advice and team support, leading workstreams, research and innovation, partnerships.

Operational Field Support Officer (1 FTE): Stock inventory, management and ordering in addition to Field Operator work, to enable smooth and efficient field operations.

Field Supervisor (3 FTE): Field staff support and leadership. Planning logistics and delivering field operations on the ground, appraisals and direct people manager of Field Operators, input on technical decisions.

Field Operator (13 FTE): Field delivery of project operations, leading smaller work initiatives, technical and observational contributions to work planning, experts in niche eradication knowledge and techniques.

Field Supervisor Community Outreach (1 FTE): Community Outreach Officer support and people leader. Coordinating outreach, permission gathering, community and volunteer operations. Key conduit between outreach and field operations.

Community Outreach Officer (2 FTE): Delivery of outreach, permission gathering and community work.

Rat Detection Dog Handler and Dog/s (1 Part-time)

Provision also needs to be made for human resources, fleet management, health and safety and technology support.

Staff training

Comprehensive staff training is a fundamental part of project establishment. PFW training includes both theory and practical modules which cover health and safety, animal behaviour, dissection, knife and tool use, community engagement, data collection and practical field skills, among others. Shadowing experienced staff in the field is highly valuable for new staff. Skills in identifying bite marks, footprints, droppings and animal sign in the environment are crucial to correctly detecting target species presence. With practice staff should be able to inspect a bait station for clues to determine which species may have consumed bait and identify whether chew marks or footprints are from an adult rat or juvenile rat, and Norway rat or ship rat.

Planning and delivery

It is important to facilitate effective communication between leadership staff, supervisors and field staff. PFW uses Microsoft OneNote to display weekly work plans, guides and important information, which field staff can view on their phones. WhatsApp is used for communication between field and office staff throughout the day.

Eradication Technical Officers (ETOs) track each work area, keeping a detailed log of activity and changes. Data from the previous day is reviewed and discussed every morning, considering whether adjustments should be made to the network or servicing frequency based on the activity found. As each area may be on a different servicing frequency, a planning schedule must be laid out several weeks in advance to manage staff capacity and ensure upcoming work can be delivered. Each Friday, the schedule and priorities for the coming week are communicated to Field Supervisors, who then assign this work to days and teams. The schedule is reviewed and adjusted daily based on staff numbers and weather conditions.

Field Supervisors focus on delivering tasks efficiently and on-time. For a project to be cost-effective it's important to monitor the rate of work and consider if operational changes can be made to increase staff efficiency. 'Effort' is a term we use to track the number of bait stations and traps serviced in a given time period. Factors like bad weather, difficult terrain, staff sickness, injury or leave can greatly impact effort and slow down operations. Efficiency can be optimised by effectively planning staff and vehicle movements.

Each week Field Operators are generally divided into three teams, each led by a Field Supervisor. These teams vary in size and members to suit the tasks to be completed, which are divided between them. One

team is always dubbed the ‘Capture team’ – their focus is on Biosecurity, maintaining the trail camera network, responding to incursions and investigating sightings. The Capture team is designed to be a highly mobile unit who carry extra equipment to be able to respond quickly at short notice.

Each workday begins with a Daily Briefing, where Field Supervisors allocate work to Field Operators for the day. Also discussed are pertinent hazards, property requirements, operational changes, data from recent visits, equipment needed and the weather forecast. Staff work individually, so communication is maintained via WhatsApp to monitor progress throughout the day, and cooperation is needed to get areas completed. A short roundtable debrief at the end of the day allows field staff to report back on any hazards, observations and findings, as well as what work was, or wasn’t, completed.

Health, safety and wellbeing

Staff, volunteer and public safety is the top priority for an urban eradication project. Continuing community support and a healthy, well-functioning team are critical to project success. A comprehensive Health and Safety plan should be written to identify and mitigate, minimise or eliminate hazards. Urban environments pose unique risks, and there will occasionally be unexpected events which must be responded to such as fire, theft or interference. Other unexpected hazards could include discarded Asbestos Containing Materials, human waste, construction sites, road closures or extreme weather events which may impact operations.

Fostering a strong health, safety and wellbeing culture and promoting reporting of near-misses, incidents or reputational damage is important for project learning, improvement and longevity. Mental health and wellbeing should also be cultivated – regular check-ins with staff can help to monitor morale and resolve issues impacting their wellbeing. Team morale will often be lowest in times of bad weather and high pressure, but setting aside time for celebration, team bonding and fun can help alleviate this.

Effective planning can also help reduce staff burnout, exhaustion and injury, such as alternating servicing of difficult and easy terrain, or rostering office-based days when needed. Valuable safety-related training courses included Thriving Under Fire (dealing with difficult people, situations and emotions, https://tuf.co.nz/), first aid, dog safety, ACM awareness (asbestos containing materials) and manual handling training (safe lifting and carrying techniques).

9. Volunteer management

Across Wellington over 2,500 volunteers dedicate more than 55,000 hours a year to achieve our predator free mission. This is a huge contribution, valued at approximately $2 million a year in support. This provides extra resource, helps to supress predator numbers, increases community awareness and support for trapping and allows the project to progress faster.

We host training sessions to upskill volunteers and coordinators, then entrust them to effectively manage their areas. Volunteers are trained to check and rebait traps and bait stations, record data, recognise signs of rat activity and understand rat habitat. Lockboxes are stationed around the city and kept supplied with the tools and equipment volunteers need. We oversee the information they provide, keep in touch with group coordinators and lend support or resources where required.

Volunteers participate via several different avenues:

Backyard trappers and reserve trapping groups

- These are local neighbourhood groups run by voluntary coordinators and supported by Predator Free Wellington.
- Most focus on trapping predators in individual backyards or public reserves.

Miramar biosecurity volunteers

- We've partnered with the volunteers who make up 'Predator Free Miramar' to monitor for and remove invaders to Miramar. A dedicated group heads out most Sundays to check trail cameras, review images and report findings. They're also closely involved in incursion response efforts on public land.
- Other Predator Free Miramar volunteers service traps and bait stations along stretches of the Miramar coastline, to help in incursion defence, or maintain traps on their own property.

Phase 2 Buffer volunteers

- The western edge of Phase 2 is protected by our buffer: an area filled with traps and bait stations that hard-working volunteers maintain. The buffer lowers the chance of rats slipping in from the west and means we can focus on our suburb-by-suburb approach.
- There are several buffer teams, each led by a community volunteer coordinator.

Phase 2 Mount Victoria volunteers

- These volunteers actively contribute to the 'knockdown' phase of the PFW eradication, doing the initial toxic baiting rounds on public reserves, and checking traps. Once rat activity has dropped to low levels, PFW staff then take over the final stages of the eradication in that area, and volunteers move on to the next. This model has been very successful in time and cost-saving.

Community partnerships

- Our work with volunteers has expanded to include partnerships with organisations or businesses within our Phase 2 project area.
- This includes working with Te Papa's Tory St facility, Massey University, Wellington College, Pukeahu National War Memorial Park and Government House. Together these areas cover more than 30 hectares. For each location, we trained staff, students or contractors to undertake eradication operations on their grounds.

10. Project outcomes

There are many ways to record positive social or ecological project outcomes. Below are some examples of outcome monitoring we use.

Wildlife outcomes

We have a network of 84 five-minute bird count stations on Miramar Peninsula to monitor the response of local bird populations over time. A single count has been carried out at each station in November or December annually between 2017 and 2024. Since the project began, we've recorded a 91% increase in native bird detections, including a 141% increase in tūī.

Social outcomes

We've commissioned or been involved in research to document some of the social impacts of the project. This has included psychological and social wellbeing benefits resulting from rat-free homes, increased wildlife and community connectivity. Participation has been widespread and equitable, leading to positive outcomes for all sectors of society, regardless of socio-economic context.

11. Key knowledge gaps

Our project has raised a number of questions which would be great topics for further research. Some of these include:

Animal behaviour

- Quantifying the relationship between target species and habitat, across a range of habitat types around the country, and implications for device density required for eradication.
- Better understanding behaviour of rats and mustelids at low density (i.e. survivor and invader animals).
- Better understanding rat movement and home range size within different environments.

Tool development

- Understanding impacts of device architecture on rat interaction – how can we improve current control tools to better suit eradication? For example, do certain colours, textures, materials or structures deter rats or mustelids? Can we create an inexpensive device with high interaction rates which is also safe for non-targets?
- Improving AI camera image species classification to a highly accurate and reliable level.
- Finding ways to reduce cost and increase the pace of operations, for example through more long-life, automated and passive control devices.
- Creating tools for detecting and removing target species from inaccessible areas, such as cliff faces.
- Ways to reduce waste, for example biodegradable chew cards.

12. Acknowledgements

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13. Glossary of PFW terms

- **Active***:* An area we are currently servicing and actively trying to eradicate.
- **Bait station:** a device which holds toxic bait, protecting it from the elements and non-target species.
- **Bait-switching**: changing between alternative lures for traps, or an alternative toxin to account for potential bait-aversion or individual taste preferences.
- **Biosecurity phase:** the final operational phase of the eradication process, when target species have been eradicated from an area and it is being monitored for reinvasion. Focuses on defence and the rapid detection and removal of invading target species.
- **Buffer**: An area we keep under active control to reduce the chance of reinvasion from uncontrolled areas into our predator free areas.
- **Devices**: the bait stations, traps and monitoring equipment we use.
- **Device architecture:** the structure or shape of traps or bait stations. For example, how enclosed or 'open' they are, which can impact an animal's willingness to interact with them.
- **Device-switching**: swapping devices for ones of a different type (e.g. a closed bait box to a more open bait tunnel).
- **District**: A broad work area at a large scale, which is further divided into several zones. Districts are usually the size of several city suburbs. At PFW, districts are denoted by a letter (e.g. District A).
- **Effort**: A tracked measure of how many devices we're servicing in a given time period. Most often impacted by factors such as staff numbers and weather.
- **Eradication**: in our urban mainland context, the complete removal of all wild populations of our target species from an area, and the detection and removal of any subsequent populations resulting from incursion events. In our project area the rate of incursion will be higher than that of more isolated areas (such as offshore islands), and efforts must be sustained to defend and maintain our eradicated status. An alternative term that is increasingly being used for situations such as ours is 'elimination'.
- **Eradication phase:** the second operational phase of the eradication process, when knockdown has reduced target species to low numbers, and servicing is less frequent. Also involves focused work to target and remove any remaining areas of activity.
- **Escarpment**: A long steep slope, often separating an area of high land from an area of low-lying land.
- **Hotspot***:* A small area within a zone which we focus extra effort on to eradicate target species. This might be the result of an incursion, investigating a potential sighting, a small area of high activity, or a persistent area which has been difficult to eradicate.

- **Incursion**: a rat, mustelid or possum re-entering one of our predator free areas.
- **Infill (**or **Infilling):** Installing extra devices in response to network gaps or high activity.
- **Knockdown phase:** the first operational phase of the eradication process, following installation of devices in a new zone. Involves weekly servicing of devices to remove most of the target species population.
- **Microhabitat:** the environment at a small or localised scale (e.g. a few square metres), which may differ from the wider habitat around it. Can include factors of vegetation species, slope, cover, density, exposure etc.
- **Monitoring:** measures or devices for detecting target species presence. This could be via footprints, chew marks, dog detection, droppings or other evidence.
- **Neophobia**: the fear of anything new or unfamiliar.
- **Network**: all our devices (bait stations, traps and monitoring) which collectively cover our work area.
- **Permission gathering:** the process of attaining consents to access and operate on private properties.
- **Phase**: the entire PFW project area is divided into five planned phases; these are large operational areas which are sequentially targeted for eradication. Miramar Peninsula was Phase 1, and Island Bay to CBD is Phase 2. Phases are further divided into districts for easier management.
- **Response:** the act of performing targeted work on top of regular servicing within a defined area. This might include installing extra devices, dog detection work and extra monitoring.
- **Retired***:* An area we have made predator-free and has entered the Biosecurity phase.
- **Rolling front:** the approach of moving progressively across the landscape, eradicating areas zone-by-zone in a forward direction. Encompasses an actively moving, virtual 'front line' of defence, with predator-free areas behind being defended from reinvasion.
- **Service** (or **servicing**): checking and resetting/rebaiting/re-luring bait stations, traps and monitoring devices.
- **Trap:** A lured device to capture or kill target species, usually enclosed in a box or shroud to minimise non-target interaction.
- **Zone**: Smaller work areas which make up a larger district, typically around 40 hectares in size. At PFW zones are denoted by their district letter, followed by a number (e.g. A1). Devices in a zone are typically installed at the same time, and then serviced on a regular rotation all together.

14. Bibliography & resources

Bell, P., Nathan, H. & Mulgan, N. (2019). 'Island' eradication within large landscapes: the remove and protect model. In: Veitch, C. R., Clout, M. N., Martin, A. R., Russell, J. C. & West, C. J. (eds). Island invasions: scaling up to meet the challenge, pp. 604-610. Occasional paper SSS no, 62. Gland, Switzerland, ICUN.

Brown, S., Samaniego, A., Pearce, J., *et al.* (2024). Trialling GPS tags to assess rat movement in response to toxic baiting in Wellington. Manaaki Whenua – Landcare Research. Contract Report: LC4455.

Dewar, E. (2023). Habitat preferences of *Rattus rattus* (ship rats) across composite urban landscapes. The Open Polytechnic of New Zealand. https://www.pfw.org.nz/resources/research/habitat-preferences-of-ship-rats-2023/

Henry, D. (2019). How to kill rats and engage a community. Predator Free Miramar. https://www.pfw.org.nz/site/assets/files/1329/predator_free_miramar_-_how_to_kill_rats_and_engage_a_community.pdf

Mackenzie, H.R., Latham, M.C., Anderson, D.P. *et al.* (2022). Detection parameters for managing invasive rats in urban environments. *Sci Rep* 12, 16520.

Pavanato, H., Bertoia, A., MacKenzie, D. (2023). Analysis of Predator Free Wellington data from Miramar Peninsula. Proteus. Client Report: 184.

Shanahan, D. 2020. The connection between people, nature and wellbeing in Wellington, Part 1. The ZEALANDIA Centre for People and Nature. https://www.pfw.org.nz/site/assets/files/2329/part_1_nature_and_wellbeing_in_wellington_2020.pdf

Veale, A. (2024). The landscape genomics of ship rats on the Miramar Peninsula. Manaaki Whenua – Landcare Research. Contract Report: LC4490.

Whitburn, J., and D. Shanahan. 2022. Collective action to eradicate rats and mustelids from a large, peopled landscape: A social-ecological approach. The ZEALANDIA Centre for People and Nature. https://www.pfw.org.nz/site/assets/files/2070/whitburn_shanahan-_2022_4.pdf

Whitburn, J., and D. Shanahan. (n.d.). The value of volunteers. https://reports.pfw.org.nz/the-value-of-volunteers/#home

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