Multi-species Elimination Design for Towards Predator Free Taranaki

Design principles and operational guidance

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CONTENTS

Report overview

This report presents an evidence based foundation to support the development of a multi-species elimination programme in Western Taranaki targeting feral cats (*Felis catus*), rats (*Rattus rattus* and *Rattus norvegicus*), stoats (*Mustela erminea*), ferrets (*Mustela furo*), weasels (*Mustela nivalis*) and brushtail possums (*Trichosurus vulpecula*). It brings together current evidence and operational experience to identify the key design principles, operational considerations and planning requirements for large-scale mainland elimination.

Expert interviews were used to identify the main operational themes that underpin this report. These themes guided a targeted review of published and grey literature, allowing evidence to be systematically integrated with the interview findings. The resulting synthesis formed the basis for the evidence-based design principles, high-level operational planning and species-specific operational guidance presented in the later sections.

The report progresses from evidence synthesis to programme design and operational planning. Sections 1-9 present the evidence synthesis, organised around the nine operational themes identified through expert consultation and supported by published and grey literature. Section 10 consolidates the knowledge gaps identified by interviewees. Section 11 distils the evidence into key design principles, Section 12 translates these principles into high-level operational planning, and Section 13 provides species-specific guidance for feral cats, ship and Norway rats, stoats, ferrets, weasels and brushtail possums.

Together, these sections provide an evidence-based foundation for programme design, allowing Towards Predator Free Taranaki to build on the collective experience of other elimination and eradication programmes and current best practice.

Programme Context

Towards Predator Free Taranaki (TPFT) is progressing towards multi-species elimination within the Western Taranaki Zero Footprint area (Figure 1), encompassing the original (2,121 ha) and extension (6,118 ha) blocks between the Hungatahua and Ōākura awa. The programme aims to eliminate feral cats, ship and Norway rats, stoats, ferrets, weasels and any remaining brushtail possums from this landscape, building on their history of intensive possum elimination operations. Possum management has now progressed to the detection and removal of remnant individuals and reinvaders, providing an advanced foundation for expanding to a multi-species programme.

The project area presents many of the challenges associated with mainland predator elimination in New Zealand. It is an open landscape with limited natural barriers, comprising predominantly productive farmland interspersed with small, fragmented patches of indigenous and exotic vegetation, urban areas and coastline. Developing effective approaches in this landscape will require strategies capable of operating across highly connected environments rather than relying on geographic isolation.

These characteristics also make the programme nationally significant. The landscape is representative of much of mainland New Zealand and provides an opportunity to develop, test and refine approaches that will be applicable to future Predator Free 2050 programmes. In particular, the programme offers an important opportunity to improve methods for detecting and removing predators at very low densities, managing reinvasion in open landscapes, understanding species interactions within mainland systems, and developing operational models that are effective across rural environments.

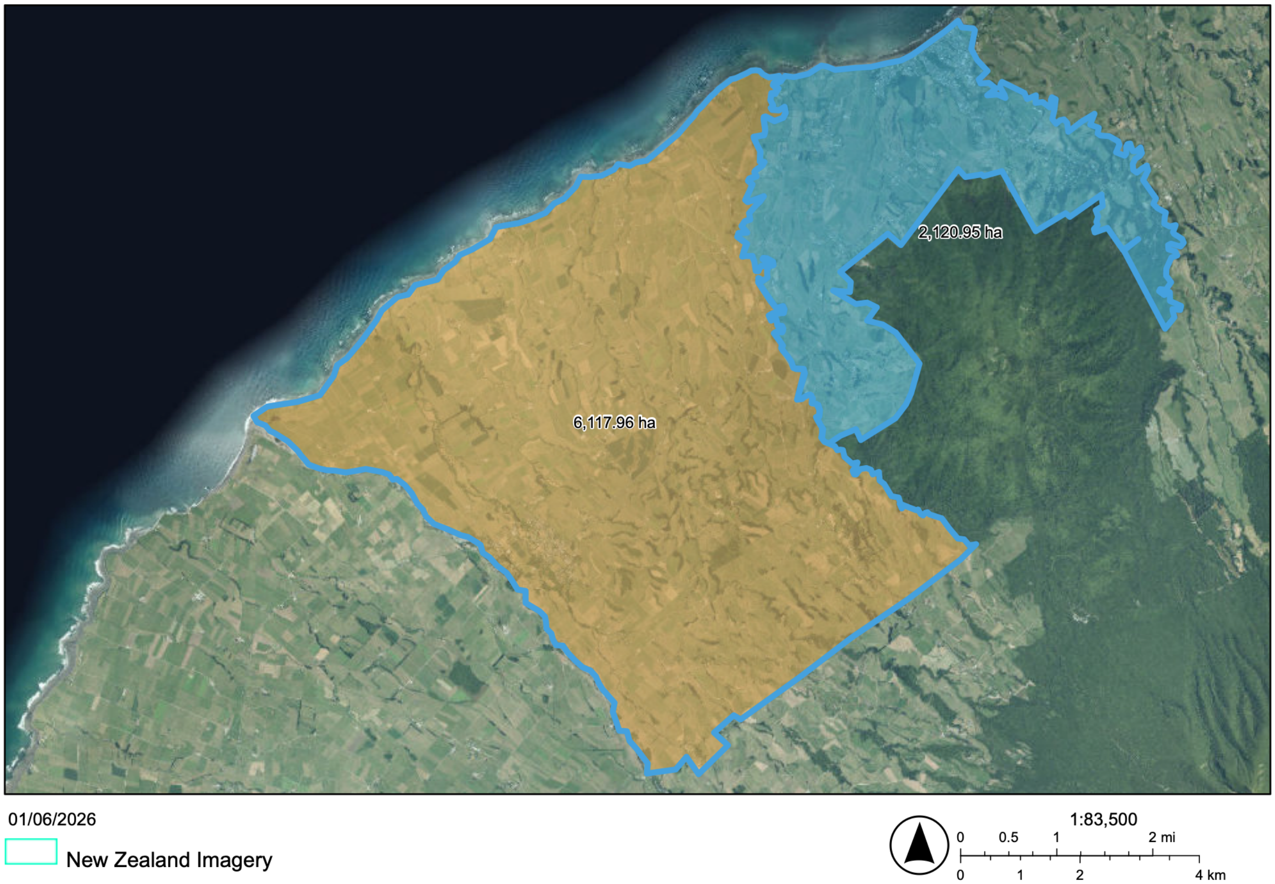

Figure 1. Map showing the Zero Footprint project area on the Taranaki ring plain. The original block (blue) and extension block (yellow) together form the zero block.

Strategic considerations

Beyond the evidence-based recommendations presented in later chapters, several broader strategic considerations emerged during the development of this report. These observations provide context for the subsequent design principles and high-level operational planning and highlight issues that are likely to influence long-term programme success in Western Taranaki.

Landscape context

Western Taranaki provides an important opportunity to develop and test multi-species elimination in a landscape representative of much of mainland New Zealand. The project area is dominated by productive pastoral farmland, with high-producing grassland comprising approximately 89% of the Zero Footprint area. Vegetated habitats account for less than 9% of the landscape, while built-up urban areas comprise less than 2%.

Despite this limited forest cover, the programme has already removed approximately 5,000 possums from the extension block and 500 from the original block. This demonstrates that substantial predator populations can be supported within highly modified agricultural landscapes and highlights the importance of understanding how target species are distributed across different habitat types. Determining the habitat associations, densities and movement patterns of rats, mustelids and feral cats within this landscape should therefore be an early priority, as these data will underpin surveillance design, control strategies and resource allocation.

The presence of several small urban settlements within the Zero Footprint provides an opportunity to trial surveillance and control approaches in relatively contained environments before wider implementation across the rural landscape. These areas may be particularly valuable for refining approaches for rats and feral cats, where social constraints, access requirements and species behaviour are likely to differ from surrounding farmland.

The inclusion of a coastal margin also warrants early consideration. Coastlines are likely to influence predator distribution, movement and reinvasion risk, particularly for Norway rats and mustelids. Understanding how species respond to coastal environments, and whether these habitats require different surveillance and control strategies, will improve programme design both within TPFT and in other mainland programmes that include coastal landscapes.

The project also benefits from an established history of predator management. Previous possum elimination has created valuable operational capability, infrastructure and relationships with landholders. However, expanding to a multi-species programme represents a substantial shift in operational approach. While possum elimination has increasingly relied on night hunting, targeted trapping and scat detection in recent years, multi-species elimination is likely to require greater use of permanent infrastructure, toxicants for some species, increased property access and more frequent servicing of devices. Previous mustelid trapping infrastructure and existing rat control networks should be reviewed to determine whether they can be incorporated into future operations.

Defining success

One of the first decisions required by TPFT is to define what constitutes success. Although elimination is often described as maintaining predator populations below a level at which they can establish breeding populations, distinguishing reinvaders from surviving individuals, or identifying whether detected animals represent breeding populations, is rarely straightforward in mainland environments. Without clear operational definitions, elimination risks becoming a moving target that is difficult to demonstrate and increasingly expensive to maintain.

Traditional eradication standards generally require prolonged periods without detections before success is declared. In contrast, mainland elimination acknowledges that occasional reinvasion may occur, making the duration of any required "no detection" period inherently arbitrary. Statistical proof-of-absence approaches can increase confidence in elimination, but typically require surveillance intensities that may be impractical or prohibitively expensive across large mainland landscapes.

The long-term objective of the programme should therefore be clearly defined before operational design begins. If the objective is to demonstrate complete absence, the programme will require surveillance systems capable of providing a high level of confidence that no animals remain, supported by proof-of-absence modelling and clearly defined performance thresholds. Alternatively, if the objective is to maintain elimination by preventing the establishment of breeding populations, surveillance should be designed around detecting population establishment rather than every individual incursion. This approach would allow a leaner surveillance network, provided it is sufficiently sensitive to identify emerging breeding populations and is supported by a reliable response capability able to remove them. These approaches require fundamentally different surveillance systems, resource commitments and measures of success.

A related strategic question is whether the long-term objective is to demonstrate that multi-species elimination is technically achievable within an open agricultural landscape, or to maintain that status indefinitely as part of an expanding Predator Free landscape, or both. Greater national clarity regarding the long-term vision for mainland elimination would assist programmes such as TPFT in aligning operational investment with future national objectives.

Programme feasibility

The evidence reviewed throughout this report consistently indicates that programme success depends as much on operational feasibility as on technical feasibility. The ability to maintain complete operational coverage, service surveillance and control devices consistently, retain effective lures and baits, and respond rapidly to detections is likely to determine programme success more than the specific tools selected. Consequently, methods that can remain deployed for extended periods with minimal maintenance, together with long-life lures and baits, are likely to provide substantial operational advantages in this landscape.

Achieving a strong initial knockdown is particularly important because it reduces the duration and complexity of subsequent mop-up operations. However, this relies on maintaining surveillance and control networks to a consistently high operational standard. Reporting the number of deployed devices is of limited value if devices are not functioning correctly, are inadequately serviced or are no longer attractive to target animals. Poor operational maintenance also increases the risk of educating surviving individuals through unsuccessful encounters, making subsequent removal considerably more difficult.

The ability to maintain this operational standard is ultimately a question of capability and capacity rather than technology. Multi-species elimination requires sufficient staff, time and resources to maintain complete operational coverage while also ensuring the team has the species-specific knowledge required to deliver and interpret surveillance and control. Feasibility should therefore be assessed against the resources required to achieve the programme objective, rather than the resources currently available. Where this standard cannot be maintained across the full operational area and multiple target species simultaneously, programme scale or sequencing should be adjusted accordingly.

Social feasibility is equally important. TPFT's existing relationships with landholders and community groups provide a strong foundation, but expansion from possum elimination to a multi-species programme will involve different target species, methods and access requirements. In particular, use of toxin and increased access to private properties will require early and transparent engagement. Relationships with iwi, neighbouring projects, landholders and community organisations should be treated as operational partnerships that contribute directly to programme feasibility and long-term delivery.

Biodiversity outcomes

The interviews undertaken for this report revealed two contrasting perspectives regarding biodiversity monitoring. Some viewed demonstrating the technical feasibility of elimination as their primary objective, with biodiversity outcomes a secondary benefit not considered directly. Others regarded biodiversity recovery as fundamental to programme success, providing both the justification for predator elimination and an important mechanism for maintaining community support.

For TPFT, the appropriate balance should be determined early. If biodiversity outcomes are expected by partners, iwi, landholders or the wider community, monitoring should commence before implementation to establish robust baselines and enable ecological responses to be measured through time. Demonstrating improvements in biodiversity may become increasingly important where predator detections become infrequent but occasional reinvasion continues, helping maintain public confidence despite the continued presence of isolated detections.

Priority questions

A consistent finding throughout the interview programme was that successful elimination is highly context dependent. Consequently, several key uncertainties should be resolved before developing a detailed operational plan.

Priority questions include:

- Which target species are present, and how are they distributed across the Zero-Footprint landscape.
- Which surveillance and control methods are most effective under local conditions, including productive farmland, fragmented vegetation, urban areas and private properties.
- Which operational approaches are socially acceptable and compatible with long-term landholder access and participation.
- What operational capacity and capability are required to implement and sustain simultaneous multi-species elimination at the intended scale.
- What roles, responsibilities and expectations should be established with iwi, neighbouring projects, community groups and other stakeholders to support long-term programme delivery.

Resolving these questions through targeted operational trials, baseline surveys and stakeholder engagement will reduce uncertainty, improve programme design and provide a stronger foundation for development of a detailed implementation plan.

Purpose

The purpose of this report is to support the development of a multi-species predator elimination programme in Western Taranaki by providing an evidence-based foundation for programme design and decision-making. It is intended to inform high-level operational planning, identify the key considerations for programme development, and consolidate species-specific operational guidance. The report is designed to support informed decision-making during programme development rather than prescribe a single operational approach.

Scope

This report is intended to support programme design rather than provide a complete operational plan. It considers the strategic, technical and operational factors that should underpin a multi-species elimination programme, while recognising that many operational decisions will depend on local conditions, future trials and programme-specific constraints.

Accordingly, the report does not prescribe site-specific operational methods, implementation schedules, budgets, staffing or standard operating procedures. Instead, it provides an evidence-based foundation to support the subsequent development of detailed operational plans and implementation strategies.

Methods

This report was developed through the integration of expert knowledge and published evidence. Thirty-three semi-structured interviews were undertaken with experienced practitioners, researchers and technical specialists representing a broad range of organisations and roles, including community operations, Predator Free project management, field operations, island eradication, iwi engagement, programme strategy, research and technical expertise.

Interviewees represented various organisations and programmes. These included Taranaki Regional Council, the Department of Conservation, the Bioeconomy Science Institute, Auckland University, Predator Free Wellington, Predator Free Rakiura, Predator Free Banks Peninsula, Te Korowai o Waiheke, Predator Free Mahia, Predator Free Russell, Predator Free Taranaki, The Halo Project (Predator Free Dunedin), Tu Mai Taonga (Predator Free Aotea), Whaka-Ora Healthy Harbour, Zero Invasive Predators, Wildlife Management Associates Ltd., Samaniego Conservation and Hoegh Hunting. Interviewees were purposely selected based on their current or previous roles in predator elimination or eradication programmes or related research, their recognised expertise and national prominence, and to capture a broad range of operational, strategic and technical perspectives.

Interview findings were captured using a consistent set of topic headings and subsequently synthesised to identify the recurring operational themes that emerged. These themes formed the headings and subheadings of Sections 1-9 and represent the areas of greatest emphasis across the expert consultation. Within each section, interview findings are organised into sub-themes representing the principal ideas that emerged under that theme. Each sub-theme includes an assessment of the strength of support, based on the approximate percentage of interviews in which that topic was discussed that supported the idea, together with the diversity of interviewee groups from which it emerged. The ratings are intended to indicate the prevalence and consistency of each idea across the interview programme rather than provide a quantitative measure of agreement.

A targeted review of published and grey literature was undertaken for each theme. Relevant evidence was extracted and integrated alongside the interview findings to develop the evidence base for each section. Section 10 consolidates the knowledge gaps identified during the interview programme. The evidence synthesised in Sections 1-10 was progressively translated into the final outputs of this report. The findings presented in Sections 1-10 were first consolidated into a set of evidence-based design principles for multi-species elimination (Section 11). These principles were then translated into high-level operational planning for Towards Predator-Free Taranaki (Section 12), with the recommended actions organised into a logical sequence to support programme development. Finally, the evidence relating to each target species was consolidated into species-specific operational guidance (Section 13), providing practical recommendations to support programme design and implementation.

Artificial intelligence tools were used to assist with literature management, thematic grouping and editorial refinement. All interpretation of evidence, synthesis of findings and final report content were undertaken by the author and verified against the original source material.

1 Strategic and operational principles

Interviewees consistently emphasised that successful elimination is driven by programme design. Across projects, the strongest recurring message was to invest heavily in planning, clearly define objectives, and adapt operations as new information becomes available rather than relying on fixed prescriptions.

Interviewees differed on whether current tools are sufficient for mainland elimination. There was also uncertainty around the most appropriate planning frameworks for mainland elimination, the operational thresholds for transitioning between phases, and how learning can be embedded into long-term programmes without slowing operational progress.

Strength of support: Very strong (approximately 80% of interviews discussing strategic and operational principles; represented across Researchers, Technical Experts, Project Managers, Strategic Experts and Island Eradication Experts).

Interviewees consistently argued that programmes should begin by defining the desired outcome before selecting species, tools or operational approaches. Several recommended using structured planning approaches such as the Pacific Invasives Initiative feasibility framework and dependency mapping to identify critical assumptions, knowledge gaps and operational dependencies before implementation. Several interviewees also referred to assessing proposed programmes against the fundamental principles of eradication, including whether all individuals can be exposed to control, reinvasion can be managed and success can ultimately be demonstrated. Multiple interviewees stressed that feasibility should be revisited as programmes evolve rather than treated as a one-off assessment.

Research Findings

- Predator Free 2050 programmes should translate long-term aspirations into SMART objectives aligned with 1-3 year funding and reporting cycles. Objectives should specify the geographic area, management tactics, survey methodology and survey effort used to measure success, and evaluation should determine whether tactics continue, change, or whether objectives need revision (Hickling & Samaniego 2022).
- Pest management programmes should clearly distinguish between eradication, elimination/extirpation and sustained control because each requires different objectives, operational strategies, surveillance requirements and long-term commitments (Parks et al. 2016; Russell 2025).
- Predator control programmes should begin with clearly defined objectives. Objectives should identify the species being protected, the target pest species, whether the objective is initial knockdown or ongoing suppression, how success will be measured, acceptable pest thresholds, monitoring methods and long-term maintenance requirements (Predator Free New Zealand Trust 2025; Kiwi Coast 2020).
- Management objectives should be driven by biodiversity outcomes. Residual pest abundance targets should be based on density-impact relationships and the biodiversity outcomes required (Parks et al. 2016; Innes et al. 2024).

- Eradication programmes should follow a structured sequence of feasibility assessment, operational planning, implementation, monitoring and confirmation of success (Broome et al. 2025).
- Successful eradication programmes require rigorous planning, disciplined implementation and experienced practitioners (Springer 2016; Innes et al. 2024).
- Many historical eradication failures resulted from operational shortcomings rather than biological impossibility. Common causes included planning deficiencies, implementation errors and inadequate follow-up (Samaniego et al. 2021).
- Independent technical review of eradication plans, including pre-operational readiness checks by experienced experts, reduces the risk of design flaws before implementation (Pacific Invasives Initiative 2011d).

1.1 Scale operations to capacity

Strength of support: Strong (approximately 70% of interviews discussing strategic and operational principles; represented across Project Managers, Operational Staff and Technical Experts).

Interviewees repeatedly cautioned against attempting to eliminate pests across larger areas than could realistically be completed or defended. Several argued that it was better to establish a well-managed core and progressively expand than to overextend operational capacity. Projects described moving away from large rolling knockdown operations towards smaller operational blocks that could be completed to a much higher standard before progressing. Smaller operational areas were also considered valuable for refining methods, testing assumptions, demonstrating proof of concept, building staff capability and maintaining public confidence before scaling up. Several stressed that programmes should only expand once previously treated areas can be defended successfully and that smaller areas were easier to defend operationally.

One operational interviewee summarised this as *“better to focus on what we’re doing and do it super well than overextend.”*

Research Findings

- Predator Free 2050 requires concurrent investment in eliminating predators from core areas, preventing reinvasion and progressively expanding predator-free areas. Managers must balance resources between elimination, surveillance, reinvasion management and expansion (Hickling & Samaniego 2022).
- Expansion of predator-free areas should only occur when the enlarged area can still be defended without allowing population recovery in the existing core (Hickling & Samaniego 2022).
- Large-scale mainland eradication is unlikely to be achieved in a single operation. Progressive expansion through stepping-stones, core-and-buffer approaches, ecosanctuaries and proof-of-concept mainland projects is more realistic (Russell et al. 2015).
- Large eradication programmes can overwhelm normal organisational functions; business-as-usual activities should be separately resourced to avoid compromising programme delivery or routine operations (Lord Howe Island Board, 2025).

- Specialist operational capability, including detection dog handlers, experienced trappers and technical specialists, should be developed before implementation because these skills cannot be generated rapidly once operations begin (DOC, 2021).
- Early recruitment of specialist staff allows sufficient time for training, operational preparation and development of project-specific expertise before field implementation (Lord Howe Island Board, 2025).
- Building sufficient skilled capacity should occur before implementation (DOC, 2021).

1.2 Local context should dictate strategy

Strength of support: Strong (approximately 70% of interviews discussing strategic and operational principles; represented across Technical Experts, Operational Staff, Project Managers and Researchers).

Interviewees repeatedly emphasised that programme design should be based on local ecology rather than generic operational prescriptions. Several recommended understanding which pest species are present, their distribution, likely reinvasion pathways, habitat use, seasonal influences and operational constraints before selecting surveillance or control methods. Researchers recommended using modelling and planning tools before implementation to compare context specific surveillance layouts and buffer configurations, reducing the need for major redesign later. Across projects there was little evidence of prescriptions of control or surveillance design that could be applied in any context.

Research Findings

- Predator control methods should be adapted to local conditions rather than applying a standardised approach. Operational decisions should account for habitat, location, season, available resources, experience, target-species ecology and observed predator behaviour, with monitoring used to refine management through adaptive management and effective communication between operational managers and scientists (Predator Free New Zealand Trust 2025; Brown et al. 2015).
- Site selection is fundamental to mainland elimination. Natural barriers such as alpine ranges and cold, fast-flowing rivers reduce reinvasion pressure, while neighbouring elimination areas further reduce immigration (Cook & Mulgan 2022; Russell 2025).

1.3 Social license is part of technical feasibility

Strength of support: Strong (approximately 65% of interviews discussing strategic and operational principles; represented across Project Managers, Researchers, Technical Experts and Operational Staff).

Interviewees consistently described social license as a fundamental component of programme feasibility rather than a communication activity undertaken after technical planning. Several argued that elimination is only feasible where both the technical and social requirements can be met, with projects frequently limited by access agreements, landholder participation or public acceptance rather than the availability of effective control tools. Multiple interviewees cautioned against underestimating the time and resources required, with several projects reporting that establishing the social foundations for operations required at least six months before field work could begin and, in some cases, dedicated full-time staff responsible for permissions and community engagement.

Several interviewees also viewed early operational areas as an opportunity to build social feasibility as well as test technical methods. Small demonstration areas were used to familiarise communities with new tools, demonstrate that operations could be delivered safely, and build confidence before expanding into larger landscapes. The recurring principle was that social license should be planned, resourced and evaluated alongside technical feasibility from the outset, rather than treated as a separate workstream after operational design has been completed.

1.4 Trapping smarter not harder

Strength of support: Strong (approximately 65% of interviews discussing strategic and operational principles; represented across Operational Staff, Project Managers, Researchers and Technical Experts).

During knockdown, broad coverage remained the dominant approach, but surveillance increasingly directed trap placement and effort during later phases. Most projects preferred to establish a grid of control devices initially, though many stressed that placing devices where animals are most likely to travel is more important than following fixed grids or convenient access routes, with increasing examples of a balance between grid coverage and targeting specific habitats as projects moved from planning to implementation stage. One example given was of increasing stoat detections seven-fold by placing cameras in locations selected by experienced field staff rather than on the prescribed grid.

Post knockdown, projects increasingly used detection dogs, scat mapping, wax tags, chew cards, camera detections and trap histories to determine where effort should be concentrated, when traps should be relocated, where methods should be adjusted, and when areas were ready to transition into long-term surveillance.

Research Findings

- Detection and response systems should be risk-based. Higher-risk areas should receive more frequent surveillance, with detections triggering rapid increases in surveillance intensity and device density (Nathan et al. 2025).

1.5 Distinctive operational phases

Strength of support: Strong (approximately 60% of interviews discussing strategic and operational principles; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Interviewees consistently described knockdown, mop-up and long-term biosecurity (with variations on terminology) as distinct operational phases, but there was little consistency in decision making on when to transition between them. Knockdown was commonly described as achieving approximately 95% population reduction, although most projects did not use quantitative thresholds to determine when that point had been reached. Instead, transitions were generally guided by practical indicators such as declining nightly dog catches, repeated detection-free leg-hold trapping, reduced wax tag activity, reduced bait take or extended periods without detections.

Several interviewees reported that predefined transition criteria proved impractical during implementation. One programme found that requiring three consecutive nights of detection-free leg-hold trapping for possums before progressing to the next property consumed substantial effort and subsequently shifted to kill traps supported by follow-up scat surveys. Another programme concluded that an initial knockdown to approximately 6–7% residual trap catch (RTC) left too many surviving possums and that 1% RTC would be a more effective target to hit before transitioning to mop-up. Several projects were redesigning operations into smaller (approximately 100 ha), intensively managed blocks intended to achieve high confidence in no detections before progressing. Collectively, these experiences highlighted that transition criteria need to be operationally achievable, continually evaluated, and refined as programmes gain experience rather than remaining fixed throughout the project.

Research Findings

- Eradication planning should conservatively assume that some individuals will survive primary control. Operational planning should include immediate intensive follow-up to remove survivors before they reproduce (Griffiths 2011; Springer 2016).
- Eradication programmes should include contingency planning from the outset. Independent technical review, adequate contingency funding and clear decision pathways reduce the likelihood of operational failure (Samaniego et al. 2021).
- Following intensive population reduction, possums may remain highly aggregated despite severe demographic disruption. Aggregation of survivors may improve the feasibility of targeted detection-and-mop-up operations (Sweetapple & Nugent 2009).
- Detect-and-respond for rats should be treated as a distinct operational phase requiring different tools and tactics from the initial knockdown. Once bait uptake declines, programmes should transition to intensive surveillance using multiple independent detection tools and continue operations until surveillance, rather than bait take, indicates eradication has been achieved (Te Korowai o Waiheke n.d.).
- When survivors are detected during surveillance, management should transition from estimating the probability of eradication to estimating the size and location of the residual population to guide targeted follow-up control (Gormley et al. 2021).

1.6 Learning as an outcome

Strength of support: Strong (approximately 60% of interviews discussing strategic and operational principles; represented across Researchers, Technical Experts and Project Managers).

Interviewees consistently supported the idea of adaptive management but several questioned whether projects are learning systematically enough. Rather than simply changing methods when something fails, they recommended designing programmes to answer specific operational questions and documenting why outcomes occurred. Several suggested structuring operational trials around clearly defined questions (see section 10 on knowledge gaps). Others recommended using modelling before field implementation to compare surveillance networks, buffer designs, trap layouts and operational costs, then using field data to test assumptions and refine future models. Several interviewees also emphasised the importance of recording both successful and unsuccessful approaches so future programmes can build on previous experience rather than repeating mistakes. New technologies were generally considered worth trialing, but several interviewees recommended validating them at small operational scales before widespread adoption.

Research Findings

- Mainland elimination should be treated as an iterative research and development programme. Early operations establish proof of concept, with methods progressively refined and adapted through experience (Cook & Mulgan 2022).
- Build operational flexibility into project planning so resources can be rapidly reallocated as evidence accumulates. Initial operational assumptions should be continually tested and revised as programmes progress (Griffiths et al., 2014).
- The eradication project on Lord Howe required continual refinement of task sequencing, operational logistics and resource allocation in response to changing circumstances (Lord Howe Island Board, 2025).
- Allow sufficient time to evaluate, revise and adapt methodologies. If a particular approach is not working, be prepared to pivot, seek external technical advice, incorporate observations from field staff and maintain a constant feedback cycle of data review and adaptation (Predator Free Wellington, 2024).
- Adaptive management was essential where uncertainty existed. Intensifying trap networks, changing trap types, varying bait and lure strategies, and modifying surveillance methods as new information became available improved programme performance on Rangitoto and Motutapu (Griffiths et al., 2014).

1.7 Previous population knowledge

Strength of support: Moderate (approximately 40% of interviews discussing strategic and operational principles; represented across Operational Staff, Researchers and Technical Experts).

Interviewees differed on how essential pre-control monitoring is but generally agreed that collecting information before operations is valuable when it directly influences programme design. Rather than estimating abundance for its own sake, interviewees emphasised understanding factors that determine how control should be delivered, including species composition, distribution, habitat use and likely operational challenges.

Operational examples included:

- One project used night hunting with detection dogs before control to map possum distribution and relative density. The information was then used to identify which control method should be applied, and where to prioritise targeted surveillance during later phases.
- Several interviewees emphasised identifying whether ship rats, Norway rats or both were present because the species occupy different habitats, respond differently to surveillance tools and often require different control approaches.
- Pre-population mapping of possums in South Westland by ZIP determined possums above the snowline would not have been exposed to a planned bait drop, which delayed operations until a time when all individuals could be exposed to control.
- Several interviewees noted that understanding the full pest community before operations begin can identify opportunities to integrate multi-species control and select devices capable of targeting more than one species simultaneously.

In contrast, one researcher argued that the starting population is less important than the number of animals that survive control, suggesting that the value of pre-control monitoring should always be weighed against investing those resources directly into elimination. Several interviewees similarly questioned the cost-benefit of extensive baseline monitoring when programmes can refine operations rapidly once control has begun.

1.8 Additional comments

- Combine the action-oriented culture of operational programmes with the experimental rigour of research organisations.
- Use modelling tools to compare surveillance, buffer and control strategies before field implementation.
- Treat learning as an explicit programme objective alongside biodiversity outcomes.
- Use apps such as TrapSome to compare trapping scenarios during planning.
- Separate research aimed at achieving zero from research aimed at learning how to achieve zero economically.

Research Findings

1.9 Data management

- GIS should be treated as core operational infrastructure for work allocation, progress tracking and coordination across large eradication programmes (Lord Howe Island Board, 2025).
- GIS-based task allocation and real-time progress tracking reduced duplication, improved coordination and allowed incomplete work to be identified quickly (Lord Howe Island Board, 2025).

- Data management systems should be designed before implementation rather than developed after surveillance programmes are underway (Predator Free Wellington, 2024).
- Automated image processing capacity should be planned alongside camera network deployment because surveillance programmes can rapidly exceed manual processing capability (DOC, 2021).
- Monitoring should be embedded throughout predator control programmes to identify which pest species are present, detect reinvasions, evaluate management effectiveness and adapt operations as new information becomes available. Trap catches, bait uptake, toxin use and infrastructure locations should be recorded so monitoring data can refine future management (Department of Conservation 2019; Brown et al. 2019; Kiwi Coast 2020).
- Large camera networks will generate image volumes beyond practical manual processing. Automated image processing should therefore be incorporated into surveillance planning (DOC, 2021).
- Artificial intelligence-assisted image classification can substantially reduce image processing requirements but should retain user verification before operational decisions are made (Te Korowai o Waiheke, 2023).

2 Species sequence and trophic interactions

2.1 Core message

Interviewees agreed that species interactions should be considered when designing multi-species elimination programmes, but there was no consensus on a single sequence for removing species. Instead, interviewees consistently recommended tailoring species order to the biodiversity objectives, local ecology, available tools and operational constraints of each programme.

Interviewees differed on whether simultaneous or staggered elimination provides the most effective long-term strategy, with several recommending experimental comparisons between the two approaches. There was also uncertainty around the strength of trophic interactions under different environmental conditions, the role of food availability in driving predator-prey responses, and whether current tools are sufficient to achieve mainland elimination across all target species. A common thread was that if knowledge, capacity, and resources allowed, projects would prefer to target multiple species simultaneously.

2.2 There is no single correct strategy

Strength of support: Very strong (approximately 75% of interviews discussing species sequence and trophic interactions; represented across Researchers, Technical Experts, Project Managers, Predator Free Advisors and Strategic Experts).

Interviewees consistently argued that there is no universally correct strategy for sequencing species during multi-species elimination. Instead, programmes should determine the most appropriate approach by considering biodiversity objectives, landscape characteristics, species interactions, available tools, operational feasibility, budget, operational capacity and social license. Several interviewees emphasised that the optimal strategy is likely to differ between landscapes and should be evaluated during programme planning rather than assumed.

Several projects described modelling alternative operational scenarios before committing to programme scope or sequencing. Examples included comparing all target species across an entire landscape with fewer species within a smaller defended area. Other programmes delayed targeting particular species because existing tools were not considered capable of achieving landscape-scale elimination or because social license needed to be established before some control methods could be implemented. In some cases, feasibility assessments fundamentally changed programme direction, with one project abandoning a proposed multi-species programme after modelling indicated a very low probability of success and instead initially focusing on a single species.

Research Findings

- Predator–prey relationships differ among systems, so pest-control outcomes for non-target invasive species and native prey are difficult to predict without site-specific monitoring. Complex communities require long-term monitoring before and after management actions, ideally using BACI designs and data that allow predator total responses to be quantified (Cliff et al. 2020).

- Tailor operational design to the most difficult target species rather than the easiest. On Rangitoto-Motutapu, rodent baiting specifications were determined by the requirements for mouse eradication rather than rats, and resulted in successful rat eradication (Griffiths et al., 2014).

2.3 Implementing simultaneous versus sequential removal

Strength of support: Very strong (approximately 70% of interviews discussing species sequence and trophic interactions; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Interviewees expressed contrasting views on whether species should be removed simultaneously or sequentially. Several considered simultaneous removal the preferred strategy where resources and operational capacity allow because it shortens programme duration, reduces opportunities for unintended trophic interactions and makes better use of integrated surveillance and control systems. Practical examples included one operational programme simultaneously controlling rats using 50 × 50 m bait station grids while trapping stoats on 400 × 400 m trap networks, and an island programme that successfully removed rats and stoats together using aerial brodifacoum.

Other interviewees favoured sequential approaches where species interactions or operational constraints could be deliberately exploited to improve detection or control. Interviewees described several ecological reasons why one species may be targeted before another. Reducing rabbits or rats before cats was suggested to reduce prey availability, increase bait attractiveness and improve opportunities for secondary poisoning. Some researchers proposed removing prey species before predators to increase predator movement and detectability, while another suggested removing cats before mustelids may increase mustelid activity. Several operational interviewees also noted that tackling one species at a time can substantially prolong programme duration unless toxins or multi-species devices allow operations to overlap. One researcher proposed experimentally comparing simultaneous and sequential approaches in matched operational areas to better understand their relative effectiveness.

Regardless of whether species were removed simultaneously or sequentially, interviewees identified opportunities to improve operational efficiency by integrating programme delivery. Examples included using cameras to monitor multiple target species, co-locating different trap types at the same site, coordinating seasonal work between species teams, using one species to improve detection or control of another through scent trails or secondary poisoning, and deploying multi-species devices such as AT220s. However, several interviewees noted that combining multiple trap types at one location increases servicing requirements and that species-specific tools are still required during the final stages of elimination.

Research Findings

- To reduce prey-switching risk, predator control should occur simultaneously or near-simultaneously with primary prey control, and ideally before the period when predators are most likely to switch to native prey (Cliff et al. 2020; Norbury 2017).

- Where all invasive predators cannot be controlled simultaneously, sequencing may need to prioritise stoats before removing apex predators because removing cats and ferrets can increase stoat site use (Garvey et al. 2021).
- Simultaneous eradication of rats and mice is generally preferable to sequential eradication. It is more cost-effective, avoids a second socially demanding operation, reduces operational risk, and prevents mouse population increases following rat removal (Samaniego et al. 2023).
- Planning should target all interacting invasive mammal species where feasible. Auckland Island adopted this approach because removing all three target species was considered the only way to maximise biodiversity outcomes and avoid undesirable ecological responses caused by leaving one species behind (Samaniego et al. 2023).
- Multi-species eradication programmes can substantially reduce costs by combining logistics, personnel, infrastructure and operational phases rather than conducting separate eradications for each species (Griffiths et al., 2014).
- The ideal operational approach is to control or eradicate all potential predators simultaneously. Where this is not feasible, managers need a detailed understanding of predator–prey relationships and likely responses to poisoning or other perturbations before undertaking large-scale operations (Murphy & Bradfield 1992).
- Where local populations form part of a wider connected eradication unit rather than independent populations, connected populations must be eradicated simultaneously if eradication is to succeed (Bagasra et al. 2016).
- Where multiple target species are susceptible to the same control technique, simultaneous eradication is generally more operationally efficient than sequential programmes. Multi-species eradications targeting cats, stoats and possums have often been completed more quickly and with less effort than equivalent single-species operations (Griffiths 2011; Springer 2016).
- Simultaneous eradication of all introduced mammals is preferred where feasible because it reduces unintended ecological interactions and maximises biodiversity outcomes (Parks et al. 2016; Innes et al. 2024)
- Predator management should recognise that removing only part of a predator community can produce unintended ecological outcomes through interactions among predator species (Norbury et al. 2024).

2.4 Species interactions

Strength of support: Strong (approximately 65% of interviews discussing species sequence and trophic interactions; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Interviewees consistently emphasised that species should not be managed independently because interactions between species frequently influenced surveillance, control and programme design. However, several researchers cautioned against assuming these interactions are universal, noting that their strength often depends on local food availability, habitat and species composition.

Operational examples included:

- Several interviewees deliberately reduced rabbits or rats before cat control to reduce prey availability, increase predator movement and improve uptake of toxic rabbit baits or opportunities for secondary poisoning.
- One programme unintentionally pre-fed cats on dead rats from implementing A24s before an aerial 1080 operation targeting rats, resulting in successful cat knockdown from secondary poisoning.
- One interviewee found reducing rats before possum control substantially decreased rat interference with Ferratox bait.
- Rats were repeatedly reported consuming possum toxicants and damaging possum chew cards, while hedgehogs consumed rat bait and interfered with mustelid traps.
- One project reported large numbers of sparrows entering traps during some seasons, temporarily reducing trap availability for target species.
- One technical expert observed that once a rat investigated a wax tag monitored by a camera, other species subsequently followed the scent trail to investigate the same device, illustrating how one species can influence detections of others.
- Several interviewees described deliberately exploiting these interactions, including positioning mustelid traps where rat activity was high, using rat scent trails to increase predator detections, and trialing social cues such as bedding material when food lures proved ineffective.
- Interviewee's reported rats frequently interfering with possum surveillance and control by consuming Ferratox bait and damaging wax tags and chew cards. Several interviewees reported that reducing rat numbers before possum control substantially reduced this interference and improved the effectiveness of possum surveillance and toxic bait deployment.
- Lure choice can also reduce non-target interference, with Lure-it Spray and Blaze reducing rat damage to chew cards compared with flour/icing sugar lures while maintaining possum detection rates; while cinnamon and aniseed formulations did not differ in possum detection (Waters et al. 2016).

Researchers also highlighted examples where commonly assumed trophic interactions were not consistently observed. Food availability was considered as important as predator removal in determining rodent responses, removing feral cats did not necessarily increase rabbit or rat populations, and evidence that ship rat removal results in Norway rat expansion was considered limited. Interviewees therefore recommended using species interactions to inform programme design while validating assumptions within each landscape rather than relying on general ecological theory alone.

Research Findings

- In invaded systems, apex predators and mesopredators can partition prey and space in ways that affect control sequencing. Ferrets targeted lagomorphs, cats targeted rodents, and mesopredators altered behaviour to reduce interference competition, restricting access to abundant prey but increasing predation pressure on diurnal native birds (Garvey et al. 2021).
- Removing apex predators can release stoats. After specialist trappers removed 17 cats and 18 ferrets over a three-week pulse, cat and ferret site use fell by 82% and 76%, but stoats increased from no detections before removal to detections at 14% of monitoring stations six months later (Garvey et al. 2021).

- Removing ship rats may increase short-term predation pressure on native birds where predators switch prey or where mesopredator dynamics change. A stratified control programme may reduce this risk (Garvey et al. 2021; Murphy & Bradfield 1992).
- Ship rat poisoning can trigger prey switching by stoats. At Mapara, poisoning dramatically reduced ship rats, but stoat abundance was unaffected and stoats shifted their diet from rats to birds (Murphy & Bradfield 1992).
- Even when rats are only controlled rather than eradicated, mesopredator release and competitive release remain potential risks. Managers should therefore anticipate whole-community responses rather than assuming partial control of one species will have isolated effects (Samaniego et al. 2023).
- Cat vulnerability to trapping increased after rabbits and rodents were removed because the loss of primary prey made cats more responsive to trapping and lures (Griffiths et al., 2014).
- Following effective predator and rat control, monitor mouse populations because competitive release may allow mice to increase and require additional management (Kiwi Coast 2020).
- Mice are an important component of stoat diets, so eliminating mice alongside rats is likely to be critical for reducing the risk of prey switching and supporting long-term suppression or eradication of stoats (Samaniego et al. 2023).
- In integrated possum and rat programmes, possum populations may first be reduced using possum-specific control before activating rat bait-station networks to reduce possum interference with rat bait (Brown et al. 2016).
- Integrated pest management should account for prey-mediated responses. Rabbit and rodent abundance strongly influence feral cat abundance, distribution and hunting behaviour, so cat control should be coordinated with prey management rather than undertaken independently (Fisher et al. 2014; National Pest Control Agencies 2018a).
- Predator-prey interactions should be considered when designing mustelid control. Rabbit control can reduce ferret populations where rabbits are the primary food source, while rat or possum toxin pulses may remove untrappable stoats through secondary poisoning. (National Pest Control Agencies 2018; Kiwi Coast 2020).
- Rabbit control can reduce ferret abundance through a bottom-up numerical response, but the strength of this response is site-specific (Cliff et al. 2020).
- Rabbit control alone can create short-term risk for native prey because ferrets switch to alternative prey before predator numbers fully decline (Cliff et al. 2020).
- Long-term suppression of rabbits or other abundant primary prey is important because fluctuating prey populations can be particularly damaging for native fauna due to the lag between predator numerical responses and immediate functional prey-switching responses (Cliff et al. 2020).

2.5 Species-specific thinking

Strength of support: Strong (approximately 70% of interviews discussing species sequence and trophic interactions; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Interviewees consistently supported integrating surveillance and control across multiple species where possible but repeatedly emphasised that species differ sufficiently in their behaviour, habitat use and responses to control that elimination cannot rely on a one-size-fits-all approach. Multi-species devices, surveillance networks and operational teams can improve efficiency, but species-specific decisions are still required for trap type, bait or lure selection, surveillance density and device placement. This is especially important when populations are reduced to the last individuals.

Operational examples included:

- AT220s were frequently identified as valuable because they simultaneously target rats and possums, while cameras and baited monitoring stations commonly detected several pest species at the same location.
- Several projects co-located different trap types to exploit shared travel routes, reducing servicing while monitoring or controlling multiple species simultaneously.
- One project reported that rat activity at baited devices attracted stoats, possums, hedgehogs and other predators, suggesting that scent trails can increase detections of multiple species.
- Several interviewees cautioned that bait and lure selection should consider all species likely to interact with the device, not only the intended target. For example, rats feeding on possum toxic bait may receive sublethal doses and become bait shy before possums encounter the bait.
- One interviewee noted that trap selection can also involve trade-offs between species. For example, DOC250 traps suited to ferrets may not reliably capture small stoats, whereas DOC200 traps may not perform as effectively for large ferrets.
- Several interviewees highlighted species-specific surveillance requirements despite integrated programmes. Mice require much denser surveillance because of their small home ranges, ship rats often interact more readily with tree-mounted devices, while Norway rat surveillance is generally more effective when concentrated along waterways and coastal habitats.
- Several researchers also identified species-specific toxins as a potential future advance, particularly for urban and populated landscapes where social license limits the use of broad-spectrum toxicants.

Research Findings

- Different pest species require different control strategies, even at the same site. Where multiple pest species threaten biodiversity, implement integrated pest management targeting all significant pest species and potential reinvaders rather than managing species independently (Brown et al. 2015; Kiwi Coast 2020).
- Mice should be considered an explicit target in multi-species eradication programmes. Failing to remove them alongside rats and other predators can allow mouse populations to increase and expand, reducing biodiversity gains and creating future management problems (Samaniego et al. 2023).
- Mouse populations are largely regulated by food availability rather than predation alone, so reducing food resources and nesting habitat should be considered alongside direct control where mouse management is required (Samaniego et al. 2023).
- Leaving mice unmanaged can reduce operational effectiveness because they consume bait and interfere with monitoring devices set for other species. They remove bait and trigger traps or cameras without capturing target animals, increasing costs and compromising rapid detection and elimination of rats (Samaniego et al. 2023).

2.6 Additional comments

- Trial simultaneous and sequential elimination in different parts of the same landscape.
- Use social cues rather than food lures when targeting the final individuals of some species.
- Multiple trap types at one site improve efficiency but increase servicing time.
- Rotate staff between species programmes as seasonal workloads change.

Research Findings

2.7 Secondary poisoning

- Secondary poisoning can contribute substantially to predator control. Stoats, ferrets and feral cats all died through secondary poisoning after consuming poisoned prey, indicating that secondary poisoning may provide a cheaper and more effective alternative to trapping in some situations (Alterio 1996).
- Toxic rat carcasses show promise as a targeted technique for eliminating remnant stoats. Stoats removed toxic rat carcasses from bait sites and were not detected again at those sites. Stoat activity declined by 94% after toxic baiting, and the study concluded that toxic rat carcasses are best used with lured detection tools to target individual stoats during elimination. A significant reduction in stoat activity was achieved using 15 toxic rat carcasses across 3,500 ha (approximately one carcass per 2 km^2), although this level of coverage relied on extensive pre-feeding of camera detection sites to understand stoat distribution (Nichols et al. 2022).
- A small Stewart Island trial found that nine of ten radio-collared feral cats died following a 1080 possum operation after scavenging poisoned possum carcasses, demonstrating the value of exploiting secondary poisoning before follow-up control (Bell & Bramley, 2008).
- On Rangitoto-Motutapu, rodent removal reduced rabbits, stoats, hedgehogs and cats through primary and secondary poisoning before follow-up control commenced (Griffiths et al., 2014).
- Where rodents and cats are both targets, prioritise rodent eradication first because cats may subsequently be removed through secondary poisoning, reducing the scale of direct cat control required. Rodent eradication programmes may also reduce cat populations following rabbit control where secondary poisoning pathways exist, although this effect is less certain and should not be assumed without supporting evidence (Pacific Invasives Initiative 2011d).

3 Trials and practical lessons

3.1 Core message

The trials show that operational lessons are often highly context specific. Several interviewees cautioned that a method that works in one landscape may not transfer directly elsewhere. There was also uncertainty around which emerging technologies will scale effectively, how much trialing is needed before implementation, and how to balance learning with the pressure to deliver operational progress.

3.2 Surveillance and control tools - trial outcomes

- Urban ship rats were harder to trap than bush ship rats in pen trials. Wooden tunnels performed best, metal tunnels performed worst, and plastic tunnels caught about half as many rats as wooden tunnels.
- Novoflow bait stations were reported as much more attractive to rats than other bait station types.
- Rat traps were placed every 50 m in a tree or on the ground across a 345 ha area. Ground traps caught rats initially, but after knockdown approximately 80% of captures were of ship rats in tree traps (in areas of dense vegetation).
- An urban trial targeting rats over 1500 ha did not achieve an effective knockdown with D-block bait.
- Autotraps and ZIP MotoLure devices were compared as possum monitoring tools over 18 months, with no difference in possum detection probability. Rats showed a preference for the ZIP auto-lure mayonnaise.

Research Findings

- Trap and device design should be treated as context-specific and species-specific rather than assuming a single best configuration (Garvey et al. 2026).
- For ship rats and Norway rats, wooden entrance designs paired with ramps are likely to improve capture rates compared with standard trap sets. Larger, non-metal and smooth entrances may be particularly important for Norway rats, which were more reluctant to enter smaller apertures and were especially averse to metal entrances (Garvey et al. 2026).
- Metal baffles, metal entrances, stainless-steel screens and wire mesh entrances can reduce rat interaction and bait take, particularly for Norway rats. Wooden ramps and block treatments produced the highest bait take for Norway rats, while ramps were also associated with the highest bait take for ship rats, although ship-rat differences were non-significant (Garvey et al. 2026).
- Even improved traps may not capture every individual because substantial individual-level variation in bait-taking means some rats consistently avoid traps despite device modifications (Garvey et al. 2026).
- Possum device encounter and interaction are separate design problems. Trapinators had a higher nightly probability of being encountered than AT220 traps, whereas AT220 traps had a higher probability of interaction once encountered, resulting in no overall difference in nightly capture

probability. Future trap design should therefore aim to improve encounter rates for AT220s and interaction rates for Trapinators (Latham et al. 2022).
- Possums did not show evidence of device shyness after initial encounters. Possums with previous encounters or interactions were more likely to encounter or interact with devices again, indicating device-happy or familiarity-based behaviour rather than avoidance (Latham et al. 2022).

3.3 Bait and lures – trial outcomes

- One trial with approximately 100 GPS collared possums found that all but one of the ~8 survivors of aerial 1080 operations had eaten bait but received a sublethal dose. One year later, they still would not touch bait in captivity. The lesson was that animals must receive a lethal dose before conditioned bait aversion develops, and there will always be a low number that don't eat the bait at all.
- One project trialed Norway rat bedding in loose-leaf tea bags as a scent lure in 50% of bait stations. There was no significant difference in bait take, although the population was mostly ship rats.
- The same project changed toxic bait targeting rats three times and recorded increased bait uptake with each bait change.
- One project found moving rat bait stations small distances increased bait uptake.
- Lord Howe Island was cited as an example where toxin mixed with avocado was considered critical for rat eradication because avocado trees were locally abundant.
- Low-density PAPP sowing was reported as successful for stoat control in Fiordland.
- One small island operation to eliminate ship rats used norbormide and then double-tap, achieving a very fast rat eradication, but the reason for success was uncertain.
- HARK ultrasonic devices are currently being trialed for possum detection in Taranaki.
- Silverbine as a long-life lure for cats is being trialed on Aotea and in Taranaki by Ngāti Mutunga trials and looks promising.
- A recent trial of pindone for the knockdown of rats by the Department of Conservation in Taranaki has purportedly been successful (results have not been reviewed).

Research Findings

- Maintaining bait attractiveness may require adaptive bait management. Changing bait types restored bait acceptance during the final stages of eradication, whereas Norway rat bedding scent did not increase bait take for ship rats under the trial conditions (Te Korowai o Waiheke n.d.).
- Laboratory trials confirmed local mice were susceptible to brodifacoum bait, allowing the baiting strategy for Rangitoto-Motutapu to be tailored confidently to mouse eradication requirements (Griffiths et al., 2014).

3.4 Surveillance and proof-of-absence – trial outcomes

- One project deliberately reduced a camera biosecurity network for rats from 1 camera per hectare to 1 camera per 5 ha. A rat breeding event then occurred across approximately 40 ha and took about three months to resolve. The project concluded that 1 camera per hectare was too intensive to manage, but 1 camera per 5 ha was not enough for rats.
- One project is statistically analysing a rat detection dog team to compare different strength detections. The aim is to develop response protocols based on detection type and confidence.
- One technical expert described a case where 27 tracking tunnels at 50 m spacing appeared to show a rat infestation within a fenced sanctuary, but it was one individual with an expanded home range at low density.
- Tracking tunnels performed poorly in one rat trial: 40 tunnels over three nights produced no detections, while traps caught three rats.
- One project considered 1 camera per 35 ha reliable for individual stoats and possums, and for detecting emerging rat populations that could then be controlled with aerial posion.
- One project compared cameras with autotraps for possums. Cameras failed to detect 160 possums that were subsequently caught in traps.
- The same project compared scat detections with cameras and found cameras missed areas where scat was detected.
- A camera relative abundance trial for stoats produced uncertainty so high that the result was considered meaningless.
- CritterPic camera trials produced images that were not considered good quality enough by one project.

Research Findings

- Automated thermal cameras with on-board AI image analysis and remote reporting are being developed to reduce servicing requirements and shorten the time between detection and response (Zero Invasive Predators Ltd. 2020).
- Paired MotoLures and cameras deployed for three weeks detected more stoats than standard tracking tunnels deployed for three days, although some stoats may still have evaded detection (Zero Invasive Predators Ltd. 2020).
- Dispensing mayonnaise lure nightly may encourage repeat predator visits, and deploying lured cameras before a removal operation may increase confidence in the network's ability to detect remaining individuals after control (Zero Invasive Predators Ltd. 2020).
- Multiple complementary surveillance tools improve confidence in detecting remnant rats at low density. Trail cameras, chew cards and wax blocks each detected rats during the final stages of eradication, demonstrating the value of using several surveillance methods concurrently (Te Korowai o Waiheke n.d.).
- Detection networks should be refined iteratively using observations from field trials. At Bottle Rock Peninsula, the surveillance network for rats evolved to peanut butter-baited chew cards and open Tun200 traps with tracking cards spaced at 80 m along coastal detection lines approximately 100 m and 300 m inland (Aitken 2016a).
- Proof-of-absence estimates should not be interpreted as certainty. A campaign estimated to have >95% probability of eradication of ship rats in a fenced sanctuary was later shown to contain an

undetected breeding population after new detections, reinforcing that proof of absence must be accompanied by ongoing surveillance and rapid response capability (Nathan et al. 2025).
- Lean surveillance networks may not detect newly invading possums immediately because dispersing animals can range widely before interacting with devices. Nevertheless, broad roaming movements indicate that relatively sparse detection networks may ultimately provide cost-effective protection against establishment if maintained over time (Pollard 2017).

3.5 Buffer, reinvasion and movement – trial outcomes

- Modified rabbit-fence buffer trials showed that most target species encountered the fence and moved left or right along it. Only one rat attempted to climb and turned back at the hot wire.
- One project was trialing staggered buffer fronts across blocks to test whether reinvasion could be prevented or reduced in smaller areas as operations rolled forward.
- H2Zero toxic bait dispensers were implemented along a river boundary/project buffer and rat detected subsequently dropped.
- DNA analysis of rats that had been trapped was being used to distinguish reinvaders from residents in a core area.
- DNA work on weasels was also described as useful for identifying whether animals were reinvaders or residents and where they came from.
- One project found that a narrow 15 ha farmland property with no access could be protected by perimeter bait stations; when access was later gained, traps inside caught no rats. The same interviewee cautioned this had not applied to larger inaccessible properties with persistent rat dispersal.

Research Findings

- Trials demonstrated that detecting a single invading ship rat is considerably more difficult than detecting a first-generation breeding event because individual invaders can have very small and highly variable movement footprints. These findings led to a shift in strategy from targeting individual invaders towards detecting and removing the first generation of offspring before they could reproduce (Aitken 2016a).
- Environmental features should inform operational design. Housing density, waterways and vegetation influenced eradication outcomes, wet weather reduced bait attractiveness, and waterways consistently acted as movement corridors for rats, indicating that surveillance and response effort should be concentrated along these features (Te Korowai o Waiheke n.d.; Nathan et al. 2025).
- Individual invading ship rats exhibited highly variable movement patterns, so surveillance networks should not assume a standard invasion footprint. Detection systems should therefore be designed to accommodate both highly localised and wider-ranging movements rather than relying on average dispersal distances (Aitken 2016a.)
- Trial observations suggested that first-generation rat incursions may be detected efficiently using relatively light surveillance concentrated around likely entry pathways. ZIP proposed that if breeding events typically occupy ≤100 ha, surveillance at approximately one device per 50 ha,

biased towards coastlines, waterways and extending approximately 1 km inland, may provide a scalable approach for incursion management (Aitken 2016b).

- Waterways consistently influenced rat movements during trial incursions. Pregnant females centred their home ranges near waterways, offspring also remained close to water, suggesting streams and similar landscape features should be prioritised within surveillance networks where appropriate (Aitken 2016b).
- Response intensity should increase immediately following detections. Increasing trap and tracking-tunnel density to a 25 × 25 m grid around detections, together with a small targeted hand-laid toxin operation, successfully removed a localised breeding population of ship rats (Nathan et al. 2025).
- Juvenile ship rats rats were generally recovered within 200 m of the mother, although dispersal ranged up to 1,510 m, and captures were concentrated around waterways. These observations suggest response operations should initially focus around the detection location and connected linear landscape features while allowing for occasional long-distance dispersal (Nathan et al. 2025).
- Natural landscape features and engineered barriers can substantially reduce reinvasion risk but should not be assumed to be impermeable. Rivers reduced possum movement outside dispersal periods, while a modified electric fence slowed but did not completely prevent possum crossings. Barrier performance therefore requires field validation and complementary surveillance (Zero Invasive Predators Ltd. 2020b).
- Possum barrier performance differed markedly between sexes. Male possums were substantially more likely than females to breach the modified electric fence (62.5% vs 12.5%), suggesting any successful invasion across this barrier would be male-biased and therefore have lower immediate establishment risk than random immigration (Zero Invasive Predators Ltd. 2020b).

3.6 Operational strategy – trial outcomes

- One project was trialing a new knockdown system intended to remove or greatly reduce the mop-up phase by intensifying control initially and doing so in smaller, easier to manage areas.
- The same project was shifting from a rolling-front knockdown followed by mop-up to block-by-block intensive effort. Blocks of about 100 ha were suggested, with the aim of reaching high confidence before moving into the next block.
- One project found that working in smaller blocks allowed faster progress than proving absence across large areas before moving forward.
- One project considered four trial categories useful: social support, effective knockdown, effective mop-up and effective low-density detection.
- One project recommended trialing methods with a willing landowner first, especially for rats because their small home range can make small-scale trials useful.
- Several interviewees suggested comparing tools directly, including cameras versus scat maps, cameras versus tracking tunnels, and different surveillance tools for low-density animals.
- A ferret trapping example showed the importance of placing traps where animals move. A 500 x 500 m ferret trap grid caught nothing, but after traps were moved to bridges in clusters of four on each side, 61 ferrets were caught.

Research Findings

- Lessons from the initial operational phases (feral cats in Te Paparahi and rodents on the Broken Islands) were explicitly used to refine methods before attempting larger mainland eradication programmes (Tu Mai Taonga, 2024).
- Trials on Auckland Island greatly informed the feasibility of cat eradication and reduced key uncertainties about operational methods before large-scale implementation (DOC, 2021).
- A staged "stepping-stone" approach should be used to trial new tools and methodologies before attempting very large eradication projects (Bell & Bramley, 2008).
- Establishing a smaller operational project around Halfmoon Bay (1,000–5,000 ha) was recommended as a practical way to test eradication methods, logistics and community engagement before progressing to an island-wide programme on Rakiura (Bell & Bramley, 2008).
- Small-scale trials should be undertaken to test methodology, improve understanding of local habitat and environmental conditions, and refine operational approaches where necessary. Review trial results and adapt methodologies before scaling up implementation (Predator Free Wellington, 2024).
- Build monitoring programmes that not only measure eradication progress but also evaluate the performance of operational methods so future decisions are informed by evidence (Predator Free Wellington, 2024).
- Urban rat eradication required an intensive knockdown followed by flexible surveillance and response. Bait stations on a 25 × 25 m grid rapidly reduced rat activity (97% reduction in bait-station visitation within five weeks), but trapping alone was insufficient for eradication and the final stages required adaptive extension of operations based on surveillance results (Te Korowai o Waiheke n.d.).

3.7 Species-sequencing and interaction – trial outcomes

- A planned operation proposes using Pindone to reduce rabbits, then deploying rabbit-based PredaSTOP approximately three weeks later, when rabbit carcasses were expected to be less attractive and fresh bait more attractive to cats.
- One project noted that reducing rats before possum control reduced rat interference with possum toxin.
- Rat numbers were reported by one technical expert to be more strongly related to food or seed availability than to mustelid control.
- Rakiura was cited as an example where 1080 worked for ship rats but less well for Norway rats and kiore.
- One project raised DOC200's by 10 cm, reducing hedgehog interference and improving stoat catch rates.

Research Findings

- Trial outcomes can identify species-specific limitations of landscape-scale tools. Simultaneous aerial 1080 was highly effective against possums, feral cats and ship rats, but Norway rats and kiore were more difficult to eliminate, demonstrating that some species require complementary tools or follow-up methods to achieve complete eradication (Predator Free Rakiura n.d.).

3.8 Additional Comments

- New technologies should be tested before being relied on.
- Trials should focus on targeting the last 5%
- Small-scale trials can help build social license as well as technical confidence.
- Some failures are useful if they reveal why a method does not work.
- The most valuable trials are those that answer a specific operational question.
- Use willing landowners as trial sites before wider implementation.

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4 General and species-specific operational principles

All the following principles have been synthesised from interview content unless listed under Research Findings.

4.1 General operational principles

- Design surveillance and control around species ecology, probability of encounter and probability of detection rather than fixed grid prescriptions.
- Ensure every individual has an opportunity to encounter a surveillance or control device.
- Using a camera grid that is as tightly spaced as logistically feasible will increase detection probability and reduce the likelihood of undetected survivors. (DOC, 2021).
- Design surveillance networks and proof-of-absence models together so surveillance data can be analysed using the same assumptions used to design the network.
- Define the surveillance objective before deployment (e.g. knockdown, detect-and-respond, proof of absence or long-term biosecurity), as each objective requires different surveillance intensity and design.
- Model alternative surveillance layouts, trap densities and trap types before implementation where possible.
- Use planning tools such as TrapSome to compare surveillance layouts, trap spacing and operational costs.
- Maintain permanent surveillance networks where possible rather than repeatedly installing and removing devices.
- Use smaller operational blocks where possible to achieve proof of absence sooner.
- Consider the trade-off between investing in dense surveillance allowing early detect and respond, versus accepting lower surveillance density and the risk of more intensive mop-up later.

4.2 General tool principles

- No single surveillance or control tool is sufficient for elimination.
- Reserve some surveillance and control tools for later operational phases to reduce behavioural avoidance and provide additional options for the final individuals.
- Combine complementary surveillance and control methods because different individuals interact with different devices.
- Tool placement is generally more important than the particular trap or device selected.
- Multi-species devices (e.g. AT220s, DOC200 double sets) can improve operational efficiency.
- Training and operator experience strongly influence programme success.
- New technologies should be independently tested under operational conditions before widespread implementation.
- Te Korowai o Waiheke incorporated annual audits, vegetation clearance, trap condition assessments and trap testing to maintain long-term trap performance.

- Tu Mai Taonga found remote trap monitoring substantially reduced manpower requirements, but traps still required twice-weekly manual servicing to refresh lures and daily responses to activations, with triggered traps legally requiring checking within 12 hours of sunrise.

Research Findings

- Design trap networks around local conditions rather than generic layouts. Consider habitat, target-species behaviour, seasonal food availability, reinvasion risk, non-target risks and site size before selecting trap configuration and density. Smaller or narrow sites with high reinvasion pressure require more intensive trap networks than standard best-practice layouts (Department of Conservation 2019).
- Where multiple predator species occur, trap lines can be integrated to improve operational efficiency, while ensuring trap types remain appropriate for each target species. DOC150 and DOC200 traps are appropriate where ship rats and mustelids are targeted simultaneously (Department of Conservation 2019).
- Limited trap numbers should be prioritised for maintaining active, functional trap sets because inactive traps disproportionately reduce capture probability in sparse trap networks. Trap locations that repeatedly capture predators are likely to remain productive and should be retained as priority trapping sites (Department of Conservation 2019; Gormley & Warburton 2020).
- During long-term predator maintenance programmes, trap networks can often be substantially reduced without major loss of effectiveness, although the degree of reduction depends on target-species ecology and movement behaviour. Increasing trap capacity beyond one trap per site provides little additional benefit for cats, stoats and ferrets during long-term maintenance operations. Simulation modelling can assist managers in optimising trap network design before implementation (Gormley & Warburton 2020).
- Before deployment, confirm traps operate correctly. Use baited triggers where appropriate to improve strike position, adjust trigger sensitivity to exclude smaller non-target animals, position traps on obvious travel routes, install traps before operations where appropriate to reduce neophobia, inspect trap performance regularly, and relocate consistently unproductive traps. Maintain a high standard of trap setting because poorly set traps increase the risk of educating animals and creating trap-shy individuals. Competition from non-target species should also be minimised through trap design or trap-setting methods where possible (National Pest Control Agencies 2015; Predator Free New Zealand Trust 2021; Gormley & Warburton 2020).
- Select surveillance devices suited to local operating conditions, and trial alternative trap types where local performance is uncertain. Trap tunnels or covers should generally be used to improve rodent approach, protect equipment from weather and reduce non-target captures (Pacific Invasives Initiative 2011b)
- Trap and surveillance device placement should be guided by habitat use and animal movement patterns rather than maintaining rigid uniform grids where operational evidence supports targeted placement (Predator Free Wellington, 2024).
- Trap layout should be modified in response to capture data rather than remaining fixed throughout the programme (Te Korowai o Waiheke, 2023). E.g., 50 × 50 m in moderate rat habitat to about 25 × 25 m in high-quality habitat, while reducing effort in low-quality habitat.

- Devices should be relocated to favourable habitat features such as dense vegetation, compost bins and other locations where surveillance indicates increased animal activity (Predator Free Wellington, 2024).
- Spacing of surveillance devices should be based on the smallest known home range across the year (DOC, 2021). For example, camera spacing of 500 × 500 m (approximately one camera per 30 ha) was effective in detecting the cat with the smallest known home range on the Auckland Islands (DOC, 2021).
- Trap type and configuration should be selected according to operational objectives rather than assuming a single design is universally optimal. For maintaining low-density possum and stoat populations, three or four single-capture traps per site generally provide a more cost-effective solution than expensive multiple-capture traps while still achieving very high capture rates. Trap sites with capacity for up to three captures are predicted to capture >97% of low-density possum and stoat populations (Warburton & Gormley 2015).
- Single-capture traps provide greater operational flexibility than multiple-capture traps because individual traps can be redistributed as pest densities decline, allowing deployment to be adapted as operations progress (Warburton & Gormley 2015).
- Trap servicing intervals should reflect lure longevity (Warburton & Gormley 2015).
- Pest detection dogs can support eradication programmes by confirming predator presence or absence following eradication, detecting incursions and reinvasions, supporting quarantine and assisting with trap placement. Rodent detection dogs can rapidly search large areas with few false-positive detections, while conventional devices such as tracking tunnels, traps, hair tubes, gnaw sticks and wax tags provide continuous multi-species surveillance (Brown et al. 2015; Gsell et al. 2010).
- Standardised camera-monitoring protocols, including consistent field of view, sampling effort and camera spacing, are needed to allow reliable comparison among monitoring programmes. Failure to detect surviving or reinvading animals can result in inappropriate management decisions, highlighting the need for highly sensitive surveillance systems during eradication and maintenance programmes (Gronwald & Russell 2021).

4.3 General lure and bait principles

- Rotate bait and lure types as operations progress.
- Utulise food, scent and social cues where appropriate.
- Use pre-feeding before toxic baiting where it improves bait uptake.
- Match bait and lure selection to the target species, operational phase and local conditions.
- Spread bait scent around devices rather than placing attractant only inside traps.
- Ensure toxic bait delivers a lethal dose to minimise long-term bait aversion.

Research Findings

- Bait station and trap spacing should be designed according to the target species, habitat and toxin being used, ensuring complete operational coverage rather than applying fixed spacing across all situations. For possum and rat control, use a minimum density of one bait station per hectare, increasing to two bait stations per hectare where higher control intensity is required (Predator Free New Zealand Trust 2021; Kiwi Coast 2020).

- Eradication baiting programmes should achieve complete treatment coverage. Clearly define the treatment area, ensure bait is available within every target animal's territory, maintain sufficient fresh bait throughout the operation, avoid interruptions caused by bait shortages, and eliminate even small gaps in bait coverage. Use freshly manufactured bait wherever possible, undertake non-toxic bait trials when bait acceptance or operational design is uncertain, and match bait application rates to target-species composition and pest density (Pacific Invasives Initiative 2011d).
- Remove uneaten bait after approximately two weeks to prevent predators encountering spoiled bait and developing bait avoidance. Avoid behavioural adaptation by varying bait types, traps and toxins over time rather than relying indefinitely on a single approach. Expanding the range of lures available may improve capture rates during final mop-up operations, although lure longevity should be considered because many scent lures remain attractive for much shorter periods than camera deployments (Predator Free New Zealand Trust 2021; Kiwi Coast 2020; Garvey et al. 2016).
- Where non-target species are at risk during possum and rat toxin operations, use repeated pre-feeding with non-toxic bait before toxic bait application to improve bait acceptance while reducing non-target risks. Combination formulations containing cholecalciferol and diphacinone provide an option for simultaneous possum and rat control while reducing secondary poisoning risks compared with brodifacoum (Predator Free New Zealand Trust 2021).
- Underperforming lure types should be discontinued when operational monitoring demonstrates superior alternatives (Te Korowai o Waiheke, 2023).
- Continue evaluating emerging lure formulations and delivery systems before operational adoption to improve long-term surveillance performance (Te Korowai o Waiheke, 2023).
- Increasing the attraction distance and interaction rate of lures would allow surveillance and control devices to be spaced further apart while maintaining effectiveness (Bell & Bramley, 2008).

4.4 Rats

4.4.1 Ecology and operational considerations

- One technical expert argued that ship and Norway rats do not necessarily require different knockdown strategies initially, with species-specific approaches becoming more important during mop-up. Others considered species-specific management important from the outset and suggested identifying which species are present before designing surveillance and control where possible, as they differ in habitat use, home ranges, lure preferences, trap requirements and responses to toxins.
- Several interviewees recommended using chew cards and cameras before operations to identify which rat species are present.
- Ship rats were generally described as arboreal, associated with bush edges, scrub and woody vegetation.
- Norway rats were associated with waterways, damp valleys, urban environments and coastal habitats.

- One operational programme found almost all Norway rat activity occurred near streams and valleys, with very little activity on ridgelines.
- Interviewees cautioned that rat ecology can be unpredictable, with winter breeding observed in one project and overlap between ship rat and Norway rat distributions differing among landscapes.
- Behaviour varied considerably between projects. Urban ship rats were reported to be much harder to trap than bush ship rats, while ship rats in urban areas were thought to remain close to sheds and other food sources.
- At Maungatautari, collared rats moved rather than progressively dispersing.
- One project found some rats occupied home ranges as small as 10 × 10 m, despite operational grids commonly being based on 50 × 50 m spacing.
- Peanut butter was reported to preferentially attract ship rats, whereas fish oil and rabbit carcasses were considered more effective for Norway rats.
- Several interviewees noted that DOC200 traps can target both ship and Norway rats, but larger entrance dimensions should be maintained for Norway rats rather than being unnecessarily restricted to reduce non-target captures.
- Rats should be able to see daylight through traps or tunnels rather than approaching a dark enclosed opening.
- Norway rats commonly cache bait, so empty bait stations do not necessarily indicate bait consumption.
- On Rakiura, aerial 1080 was considered effective for ship rats but less effective for Norway rats and kiore.
- Some interviewees considered toxin alone sufficient for ship rat elimination, whereas others consistently introduced trapping during mop-up to target animals unlikely to consume bait.

Research Findings

- For ship rats, populations can recover rapidly following successful control, with recovery observed within 2–5 months after approximately 90% population reduction. Long-term programmes should therefore incorporate ongoing surveillance and maintenance rather than assuming suppression will persist after operations cease (Innes et al. 2001).
- Population ecology differs between ship rats and Norway rats. Ship rats are generally more abundant in native forest and exhibit strong seasonal fluctuations, whereas mainland Norway rats occur as relatively small colonies associated with waterways and breed throughout the year (Innes et al. 2001).
- For ship rats, ground-based tools remain operationally valid despite arboreal behaviour because rats often travel on the ground. Traps, bait stations and monitoring devices can therefore all be set effectively at ground level (Hooker & Innes 2010).
- For ship rats, movement within home ranges means lured traps or bait stations are likely to be found if placed within the animal's range. At Rotoehu, 100 m bait-station spacing was expected to expose most ship rats to poison, while 50 m spacing was expected to expose all individuals under similar densities (Hooker & Innes 2010).
- For ship rats, a lack of strongly hierarchical colony structure may reduce the time required for poisoning because dominant individuals are less likely to exclude others from feeding stations. Several small bait containers may therefore reduce interactions compared with one large container (Hooker & Innes 2010).

- Collect and retain pre-eradication DNA samples so that later detections can distinguish survivors from reinvaders and identify source populations. Reinvaders should be captured before breeding because new generations reduce genetic source resolution (Pacific Invasives Initiative 2011b).

4.4.2 Surveillance

- Combine multiple surveillance methods because rats do not consistently interact with every device, even within the same landscape. Several interviewees deliberately used wax tags, chew cards and cameras together because engagement differed between sites.
- Commonly used combinations included cameras, tracking tunnels, wax tags, chew cards and rat detection dogs.
- Cameras were considered essential by several projects because some rats ignored every other surveillance device.
- Several interviewees emphasised adapting surveillance density and methods as populations declined rather than relying on a single surveillance approach.
- One technical expert described a final surviving rat whose home range expanded to approximately 16 ha, making 27 tracking tunnels appear to indicate multiple rats. The animal never bred and all tracking ceased after it was removed.
- The same interviewee suggested that, once rats reach extremely low densities and home ranges expand, surveillance spacing of approximately 200 × 200 m may have been sufficient despite operational grids originally being 25 × 25 m and 50 × 50 m.
- Cameras around compost bins in urban areas performed much better than cameras elsewhere.
- On project found 1 camera per ha too resource intense but 1 per 5 ha not adequate to detect remerging populations, suggesting the best grid design would be somewhere in the middle.
- One project considered chew cards to have limited value in some situations despite deploying them every 50 m.
- One project questioned the necessity for surveillance where detections will not spark a response, such as when using long-life toxic lures to eliminate ship rats in farmland. Instead relying on 400 × 400 m grid of traps that target stoats and rats to detect emerging populations.

Research Findings

- Detecting remnant rats requires multiple complementary surveillance methods because no single technique consistently provides optimal detection at very low densities. Baiting surveillance devices substantially increases rat detectability, with baited tracking tunnels and motion-sensor cameras increasing detection by 363% compared with unbaited devices. Surveys may also be more effective immediately following heavy rainfall (Davis et al. 2025).
- Motion-sensor cameras and emerging technologies have improved low-density rat detection, but effective biosecurity still depends on understanding rodent behaviour, optimising surveillance design and rapidly intercepting reinvading animals before establishment (Davis et al. 2023; Russell & Broome 2016).

- Permanent rodent monitoring stations should combine multiple detection devices, such as snap traps, tracking tunnels and wax tags, to improve detection of surviving or reinvading rodents (Pacific Invasives Initiative 2011b).
- Tracking tunnels are generally more suitable than traps for detecting very low-density rodents because they create less avoidance, require less maintenance, can remain deployed longer and allow larger areas to be monitored (Pacific Invasives Initiative 2011b).
- Place tracking tunnels where rodents are most likely to move or forage, such as near shelter, seed fall, fruiting trees, vegetation edges or buildings. Tunnel spacing should generally be no more than 50 m for rats, while mice may require 10–25 m spacing (Pacific Invasives Initiative 2011b).
- At very low rodent densities, increase surveillance effort by allowing more monitoring time, increasing tunnel coverage, or moving tunnels after several nights to improve the chance of animals encountering devices across habitats (Pacific Invasives Initiative 2011b).
- Tracking tunnels were used as the primary surveillance tool to detect surviving ship rats and trigger targeted follow-up control at Maungatautari (Speedy et al. 2007).
- For ship rats, tracking-tunnel indices provide a cheap, reliable method for monitoring changes in abundance and should be coupled with removal-trapping experiments or poisoning operations to interpret control outcomes. One-night tracking indices can efficiently provide a sufficiently precise index of abundance before and after poisoning and may be more informative than monthly indices for measuring poisoning impact (Brown et al. 1996; Innes et al. 1995).
- For ship rats, surveillance should be concentrated around likely invasion pathways and combine complementary detection methods rather than relying on a single tool. Cameras, chew cards, tracking tunnels and other surveillance devices each detect different subsets of animals, increasing overall detection probability when used together (Nathan et al. 2020; Davis et al. 2023).
- For ship rats, motion-activated cameras provide greater sensitivity than Goodnature A24 strike counters once populations reach very low density because cameras detect animals without requiring trap interaction. Strike counters should therefore not be relied upon alone to demonstrate eradication (Gronwald & Russell 2021).
- For ship rats, detecting a single invader requires intensive effort. Surveillance programmes should therefore prioritise detecting newly established breeding populations rather than individual invaders where possible because breeding events create a larger and more detectable footprint while still allowing rapid response before widespread establishment (Nathan et al. 2020).
- For ship rats, demonstrating eradication requires a dedicated post-operational surveillance network rather than relying solely on the absence of captures during control operations (Mackenzie et al. 2022).
- Rodent detection dogs provide a highly sensitive surveillance tool capable of detecting very small numbers of rats over large areas and complement conventional surveillance methods because they do not rely on rodents interacting with baited devices. Operational deployment should account for search-line spacing (approximately 100–140 m) and avoid immediately reusing dogs after confirming and removing a detected rodent (Gsell et al. 2010).

4.4.3 Control

- High-density bait station networks were commonly used for knockdown, followed by trapping and targeted surveillance during mop-up.
- Several interviewees considered 25 × 25 m bait station spacing appropriate where complete removal was the objective, particularly in urban areas, although successful eradications were also reported using 50 × 50 m grids, indicating spacing should reflect landscape and operational context.
- Several interviewees emphasised changing bait types during operations because not all rats will accept the same bait and bait acceptance changes through time.
- One project reduced rat tracking from 92% to 2% across 350 ha using 100 m trap lines, 50 m bait station spacing and pre-feeding before Pindone application.
- One project found rats persisted after 16 weeks on brodifacoum blocks before sequentially changing to Contrac blocks and then Pestoff pellets, with each bait change increasing bait uptake.
- Some projects prefer toxic bait in pellet form so rats can take the bait back to the nest, while others prefer block baits which reduce the potential dispersal of toxic bait in the landscape.

Trusted control tools

- Victor traps, particularly when placed in trees for ship rats.
- DOC200 traps, particularly wooden double-set designs that also catch stoats and weasels.
- Custom Te Korowai o Waiheke double-set DOC200 wooden boxes with baffles and ramps.
- Bait stations for knockdown followed by trapping during mop-up.
- Brodifacoum and 1080 for knockdown.
- H2Zero toxic bait dispensers.
- ZIPIN weighted traps where toxins cannot be used.
- AT220s when functioning well and maintained correctly.

Limitations and issues

- Trex traps produced too many live captures in one project.
- Several operational interviewees criticised A24s because of maintenance requirements, reliability issues and clogging.
- One project reported Goodnature traps performed poorly for rats.
- One researcher cautioned that norbormide appears less effective for ship rats than for some other rodent species.

Research Findings

- Aerial broadcast of brodifacoum cereal bait is the lowest-risk rodent eradication approach. Where aerial baiting is not feasible, hand-broadcast brodifacoum should be investigated next, followed by brodifacoum bait stations. Diphacinone cereal bait is a higher-risk alternative and should only be considered in bait stations (Pacific Invasives Initiative 2011d).

- Fast-acting acute toxins such as cyanide and 1080 are not reliably effective for rodent eradication because sublethally exposed animals may associate illness with bait and avoid further bait uptake (Pacific Invasives Initiative 2011d).
- Trapping alone should not be treated as a reliable rodent eradication technique except possibly on extremely small islands (<5 ha), because some rodents are likely to escape or become trap-wary and eradication requires all individuals to be targeted (Pacific Invasives Initiative 2011d).
- For ship rats, modelling indicates that conventional trap densities may fail to expose all individuals to trapping. Where rat densities remain moderate to high, an initial toxin knockdown followed by trapping may provide a more effective and cost-efficient strategy than trapping alone (Warburton & Gormley 2015).
- Rat baiting should achieve continuous coverage across the whole treatment area as quickly as possible (Pacific Invasives Initiative 2011c).
- Broadcast rat eradication operations should usually use two bait applications, ideally 7–10 days apart. The second application reduces failure risk by covering young emerging after the first bait has disappeared, providing insurance against rain-damaged bait, and reducing the consequences of undetected bait-coverage gaps (Pacific Invasives Initiative 2011c).
- Rat bait should be spread widely rather than placed in piles or directly into burrow entrances because rats locate bait by smell and do not require bait placed immediately in front of them (Pacific Invasives Initiative 2011c).
- Rat baiting plans should identify and treat all areas where the main application may leave gaps. These include steep slopes, tiny offshore islets, coastal margins, high-density areas, caves, buildings, wharves and offshore rock stacks exposed at high tide. These sites should be listed before the operation, hand-baited where required, and checked off once treated (Pacific Invasives Initiative 2011c).
- Coastal margins should receive additional rat bait treatment because rat densities are often highest there (Pacific Invasives Initiative 2011c).
- Where rats have abundant natural food available year-round, bait acceptance trials should be undertaken during feasibility assessment to confirm that all rats will eat the proposed bait (Pacific Invasives Initiative 2011c).
- Rat eradication operations should reduce access to alternative foods by securing rubbish, food waste, household food and field-team food scraps in sealed containers, with local community support where people occupy or use the treatment area (Pacific Invasives Initiative 2011c).
- Bait-station grid spacing should be based on the most spatially constrained target species and local conditions. For ship rats and Norway rats, 50 × 50 m may be sufficient, but spacing should be reduced in dense vegetation or high-density areas, with 30 × 30 m or 25 × 25 m used where uncertain. For kiore, spacing should always be 25 × 25 m or smaller, and mice may require 25 × 12 m. Where multiple rodent species are targets, surveillance and control spacing should be based on the species with the smallest home range or movement distances to ensure all target individuals can encounter monitoring or control devices (Pacific Invasives Initiative 2011c; Pacific Invasives Initiative 2011b).
- Rat bait stations should be installed at least one week, and preferably two weeks or more, before bait is introduced to reduce neophobia and increase the likelihood that rats enter stations once bait is added (Pacific Invasives Initiative 2011c).
- Rat bait stations should be checked frequently enough to ensure bait remains continuously available. Daily checks are preferred where possible, with bait take recorded and stations

replenished. Reduced checking frequency is only appropriate where managers are confident bait will remain available between checks (Pacific Invasives Initiative 2011c).

- Rat bait-station operations should continue for several weeks. Bait stations should generally remain baited for at least two weeks after the last sign of bait take and often one month or longer because rodent activity usually takes at least two weeks to slow. Bait stations should remain baited for at least one month after the last evidence of rat bait take or suspected take, with an alternative bait or toxin added where possible to target surviving bait-averse rodents (Pacific Invasives Initiative 2011c).
- Bait-station entrance size should match the target species and non-target risk. Entrances should be at least 90 mm for Norway rats, at least 60 mm for kiore, and as small as 45 mm for ship rats where non-target access is an issue (Pacific Invasives Initiative 2011c).
- Use only bait-station designs proven in prior eradication projects unless extensive field testing confirms all target individuals will enter a new design. Wooden tunnel designs are favoured by rats, while plastic tunnels are commonly used because they are cheaper, lighter and more durable. Wooden tunnels may be useful where reinvasion risk is high or bait stations will remain part of island biosecurity (Pacific Invasives Initiative 2011c).
- Select rodent traps by target species. Large rats can escape mouse traps and mice may not reliably trigger rat traps, so where both rats and mice are possible, use one rat trap and one mouse trap at each station (Pacific Invasives Initiative 2011b).
- Victor Professional snap traps are effective and portable for ship rats and kiore but are less reliable for Norway rats. Norway rats have been observed escaping, so careful trap setting is required to avoid creating trap-shy animals (Pacific Invasives Initiative 2011b).
- Place rodent traps where animals naturally travel or forage, including beside rocks, logs, tree bases, overhanging vegetation, droppings, food remains and runways. Traps should be stable and level because poor trap encounters, especially for Norway rats, can lead to avoidance (Pacific Invasives Initiative 2011b).
- Trial several bait types before monitoring because preferences vary among rodent species and individuals but use the same bait throughout an index-trapping programme to maintain comparability. Peanut butter mixed with rolled oats is a reliable standard bait (Pacific Invasives Initiative 2011b).
- No single rat lure performed consistently across all seasons. Lure selection should be adapted to seasonal food availability and natural diet (Tu Mai Taonga, 2024).
- For ship rats, repeated use of the same bait, lure, flavour or texture can reduce poisoning effectiveness through learned aversion. This risk can be mitigated by pre-feeding, using second-generation anticoagulants such as brodifacoum, or varying bait flavour and control methods (Innes et al. 1995).
- For ship rats, bait availability is more important than excessive bait density (Hooker & Innes 2010).
- For ship rats, urban eradication modelling indicated that device spacing of 25 × 25 m consistently produced a high probability of eradication. Surveillance data should be used adaptively to increase local device density around high-risk features (e.g. compost bins) and to modify lure type or control method where rats investigate but avoid devices (Mackenzie et al. 2022).
- For Norway rats, 1% norbormide bait reduced field activity by 96–100%. Norbormide showed low secondary poisoning risk because it is rapidly metabolised and is highly species-specific, although further field validation is required before wider operational use (Shapiro et al. 2020).

4.5 Cats

4.5.1 Ecology and operational considerations

- Feral cats were consistently described as one of the most behaviourally challenging species to eliminate.
- Young cats were generally considered straightforward to remove, whereas older individuals, breeding females and long-term survivors were substantially more difficult.
- Several interviewees reported breeding females having smaller home ranges and behaving more cautiously than other feral cats.
- Excessive disturbance around feral cats can cause individuals to relocate 2–3 km, requiring surrounding trap networks to be activated as well as localised traps around detections, reinforcing the need for cautious, low-disturbance operations.
- One project dissected trapped females to determine breeding status and found litter sizes increased as cat density declined, providing useful information on operational progress.
- Winter was considered the most productive trapping period.
- A distinction was made between cat detection dogs and hunting dogs with the latter mainly useful for applying pressure on hard to trap individuals rather than catching cats.

Research Findings

- Specialist input from experienced cat eradication practitioners and feral cat ecologists should be obtained when planning cat eradication because method sequencing, survivor behaviour and site-specific ecology strongly influence success (Pacific Invasives Initiative 2011).
- Cat operations must maintain very high standards of trap setting and method sequencing because cats that experience but escape control attempts can become much harder to catch, increasing project duration and cost. Recording trap type, set, lure, and toxic bait used is important during eradication because knowing what a problem cat has not already encountered can guide late-stage targeting (Pacific Invasives Initiative 2011).
- Cat control success depends on local predator-prey relationships, prey availability and whether the population is primarily scavenging or hunting. Food-based control and monitoring can perform poorly when prey is abundant or cats are not hungry, making local ecological knowledge critical for planning (National Pest Control Agencies 2018a; Fisher et al. 2014).
- Cats may be easier to trap during seasonal food shortages, with higher trapping rates reported in late autumn to early winter, while poor weather can reduce catches (National Pest Control Agencies 2018a).
- Operational spacing of traps and surveillance devices should be based on local movement data wherever possible rather than applying generic spacing guidelines (Fisher et al. 2014).
- Cat eradication generally requires a rapid knockdown phase followed by a persistent follow-up phase and prolonged monitoring to confirm success. The knockdown phase should aim to target all individuals and remove at least 90% of the population, because the higher the initial knockdown, the easier and more cost-effective follow-up is likely to be (Pacific Invasives Initiative 2011).
- Cat eradication should progress from passive, low-disturbance methods to more direct methods such as dogging and shooting. It is preferable to remove fewer cats initially without educating

survivors than to remove more cats while leaving wary individuals that avoid humans or devices (Pacific Invasives Initiative 2011).
- Follow-up methods should begin as soon as the knockdown effect has fully manifested, but not all techniques should be used at once. Remaining cats are likely to be more cautious and wary, so at least one highly effective method should be reserved for later or emergency use (Pacific Invasives Initiative 2011).
- GPS tracking showed mean home ranges of 1772 ha (range 176-6860 ha) for male cats and 354 ha (range 116-654 ha) for female cats, highlighting the need to design surveillance around the smallest annual home ranges (DOC, 2021).

4.5.2 Surveillance

- Surveillance becomes increasingly targeted as cat density declines.
- Minimise disturbance during surveillance because cats may relocate following human activity.
- Cameras were the primary surveillance tool, supported by cat detection dogs and community reports.
- Cameras were positioned primarily along ridgelines, fence lines, tracks and other preferred travel routes, typically at approximately 400 m spacing rather than on uniform grids.
- Camera footage was reviewed monthly during knockdown and every three weeks during mop-up by one project.
- One project deliberately waited until cameras accumulated approximately 5-10 detections of an individual before commencing intensive trapping, allowing movement patterns to become established rather than targeting transient animals.
- Cat detection dogs were considered particularly valuable during mop-up for identifying crossing points on tracks and directing trap placement.
- One operational interviewee expressed caution about relying on AI image recognition until accuracy improves.

Trusted Surveillance tools

- Cameras.
- Cellular sensors (celium nodes) on cage traps and leg holds
- Cat detection dogs.
- Community reports.

Research Findings

- Seasonal food resources should be considered when planning surveillance because cats altered movements to exploit breeding seabirds during fledging periods on Auckland Island (DOC, 2021).
- Monitoring should continue after apparent elimination because surviving or reinvading cats may remain undetected for prolonged periods if surveillance intensity is reduced too early (Pacific Invasives Initiative 2011; National Pest Control Agencies 2018a).

- Camera surveillance is an effective complement to trapping because cameras detect cats without requiring trap interaction, help identify trap-shy individuals, and allow managers to adapt trap placement, lure choice and follow-up methods (Fisher et al. 2014; National Pest Control Agencies 2018a).
- Detection dogs provide a valuable follow-up tool for locating remnant feral cats, particularly where conventional surveillance has failed to confidently demonstrate absence (Pacific Invasives Initiative 2011).
- Bait-take is not a robust method for estimating feral cat abundance because it is strongly influenced by season and prey availability. Monitoring approaches that identify individual cats are more useful for estimating abundance and assessing control effectiveness (National Pest Control Agencies 2018a; Fisher et al. 2014).

4.5.3 Control

- Several interviewees considered cage traps the primary control tool for cats, with kill traps and leg-holds introduced later to target difficult individuals.
- One project recommended cage traps rather than leg-holds within 150 m of dwellings to reduce the risk of capturing companion cats. Other projects used only cage traps across the whole project area, and leg holds in non-populated areas for mop up.
- Cage traps should remain permanently in position because cats often investigated them many times (up to 20 visits) before entering.
- If a cage trap moved while a cat was investigating it (by jumping on top), the animal often abandoned the trap permanently.
- Replacing angled drop doors with vertical doors prevented cats pushing their way back out of cage traps.
- Traps were concentrated along travel routes rather than arranged in uniform grids.
- Trap networks were positioned primarily along ridgelines, fence lines, tracks and other travel routes, commonly at 200–300 m spacing.
- One project concentrated trapping between April and August, reduced effort during October–December when breeding females were difficult to target, then increased trapping between January and March when kittens appeared to prevent them establishing territories.
- Hunting dogs were considered useful mainly for applying pressure to cats rather than catching them directly.
- Several interviewees stressed distinguishing feral cats from companion cats during operations and public engagement by consistently referring to “feral cats” in communications, maintaining voluntary photographic catalogues of owned cats, and recognising collars and ear clips as more useful field identifiers than microchips during rapid operational responses.
- Rotate food lures frequently rather than relying on a single attractant.
- One operational programme rotated rabbit, chicken, fish and cat food weekly.
- Long-life lures become increasingly useful during later stages of elimination.
- Trials using long-life silverbine on Aotea and in Taranaki were considered promising.

Trusted control tools

- Cage traps.
- Leg-hold traps.
- Cat detection dogs directing targeted control.
- PAPP in chimney tunnels following pre-feeding (one project).
- Celium sensors.

Limitations and issues

- One operational interviewee considered kill traps less effective because cats are reluctant to place their heads into enclosed devices.
- One interviewee questioned whether PAPP bait stations provide an advantage over kill traps if cats still have to place their heads into the device.

Trusted lures

- Rabbit.
- Chicken.
- Fish.
- Cat food.

Research Findings

- Cat eradication should not rely on a single method (Pacific Invasives Initiative 2011).
- If cat presence is detected during follow-up, the first response should be to intensify traps in the affected area. If this fails, managers should switch to different trap types, lures, toxic baits, trained dogs or other targeted methods (Pacific Invasives Initiative 2011).
- Cats readily develop trap avoidance following unsuccessful capture attempts. Trap performance should therefore be maintained to a high standard, trap sites should be selected carefully, and poorly performing traps should be modified or replaced to minimise educating surviving cats (National Pest Control Agencies 2018a; Pacific Invasives Initiative 2011).
- Cats can be removed through secondary poisoning during brodifacoum baiting for rodents, but outcomes are variable (<50-100%) and survivors should be expected. Standard rodent or rabbit bait rates do not need to be altered when cats are also targeted, but follow-up cat-specific methods must be planned (Pacific Invasives Initiative 2011).
- No cat poison options used to date are particularly effective for eradication on their own, so toxic baits should be treated as one part of a broader sequence rather than a complete eradication solution (Pacific Invasives Initiative 2011).
- Trap placement should prioritise locations that maximise cat encounter rates rather than rigid grid spacing. Productive sites include ridgelines, fence lines, tracks, roads, stream margins, ridges, saddles, rabbit colonies, stock camps, scent-marking sites, travel routes and habitat edges. Trap placement should be adapted using field sign and previous capture history (National Pest Control Agencies 2018a; Kiwi Coast 2020).

- Feral cat trap spacing should reflect local cat density, habitat and home-range size rather than fixed prescriptions. trap density should maximise the probability that every individual encounters a device (National Pest Control Agencies 2018a; Fisher et al. 2014).
- Trap sites that repeatedly catch cats should be retained because cats consistently use preferred movement routes. Additional traps can be clustered around productive sites to improve removal of remaining individuals (National Pest Control Agencies 2018a; Kiwi Coast 2020).
- Cage traps are most appropriate in urban or sensitive areas where domestic cats, people, stock, dogs or native non-targets may be at risk, because captured domestic cats can be released unharmed. However, cage traps are bulky, labour-intensive, require daily checks and are generally less effective than leg-hold traps for broadscale control or hard-to-catch cats (National Pest Control Agencies 2018a; Pacific Invasives Initiative 2011).
- Kill traps should only be used where domestic cats are unlikely to be captured (National Pest Control Agencies 2018a).
- Fresh food lures generally outperform processed products for feral cats. Rabbit is consistently one of the most effective lures, but fish, chicken and other fresh meat lures can also be effective depending on local prey availability. Rotating lure types can help maintain cat interest during long operations (National Pest Control Agencies 2018a; Kiwi Coast 2020).
- Lure performance depends on freshness. Fresh meat lures should be replaced regularly because deteriorating bait reduces cat attraction, particularly during warm weather (National Pest Control Agencies 2018a).

4.6 Mustelids

4.6.1 Ecology and operational considerations

- Interviewees distinguished between stoats, ferrets and weasels, noting that each requires different surveillance and control approaches.
- Two interviewees described weasels as particularly difficult because they are too light to reliably trigger DOC150/DOC200 traps and similar devices.
- One interviewee suggested weasel populations are strongly influenced by mouse and invertebrate abundance.
- One technical expert described ferrets as relatively easy to remove once detected.
- One researcher suggested predator interactions may influence mustelid populations, proposing that cats and ferrets may suppress stoats, while stoats suppress weasels.
- One operational programme reported approximately 95% of stoat captures occurred within 100 m of waterways, although some stoats were still captured elsewhere in the landscape.
- During a ferret incursion at Tongariro, an initial 500 × 500 m trap grid caught no ferrets. Relocating traps into bridge crossings in clusters of four subsequently captured 61 ferrets, demonstrating the value of concentrating effort at movement bottlenecks rather than maintaining uniform trap spacing.

Research Findings

- Female stoats generally have smaller home ranges than males and therefore determine the minimum trap or surveillance spacing required for eradication or complete landscape protection. Trap layouts designed around average or male home ranges risk leaving some females unexposed to control devices (Smith et al. 2015).
- To intersect all female stoat home ranges, line spacing may need to be ≤400 m. Spacing of 1,000 m was estimated to miss about 5% of females (Smith et al. 2015).
- For stoats and ferrets, trapping effectiveness depends more on maintaining high encounter probability than maximising trap density. Increasing trap density beyond that required to expose every home range provides diminishing operational returns (Gormley & Warburton 2020; Smith et al. 2015).
- For stoats, trap interaction varies among individuals. Shy, less active, less exploratory and less neophilic stoats tend to interact less with devices, trap recalcitrance is greatest in shy females, and current monitoring may be biased toward bolder males. Surveillance and control programmes should therefore assume that not all individuals are equally detectable or trappable (Johnstone et al. 2024).

4.6.2 Surveillance

- One technical expert reported approximately a seven-fold increase in stoat detections by positioning cameras where an experienced trapper expected stoats to travel rather than following the prescribed monitoring grid.
- One example was provided of tracking tunnels working well for surviellence of stoats in Fiordland, but other interviewee’s were skeptical.
- Cameras with lures are generally considered the most reliable option but are not well trusted.
- One project relied heavily on community sightings for stoat detections and this worked well in subsequent successful captures.

Trusted Surveillance tools

- Stoat detection dogs.
- Cameras.
- Community reports.
- Tracking tunnels (reported from one Fiordland project).
- AI thermal cameras (one technical expert).

Limitations

- One operational programme found cameras ineffective for detecting remaining stoats.
- One technical expert did not trust cameras for stoats or weasels because of their small size.

Research Findings

- Stoats respond strongly to olfactory cues from other mustelids. Predator kairomones, especially ferret scent and other mustelid odours, increased stoat inspection, time spent at foraging units and risk-assessment behaviour, indicating that scent lures may improve surveillance sensitivity where conventional food lures perform poorly (Garvey et al. 2015).
- Tracking tunnels may not be reliable for mustelid monitoring in all contexts. In Northland, mustelids avoided tracking tunnels and alternative tools such as cameras or monitoring dogs were recommended (Kiwi Coast 2020).
- Long-term mustelid programmes should maintain surveillance following successful knockdown because reinvasion can occur rapidly and trap catch alone may not reliably indicate absence of stoats or ferrets (National Pest Control Agencies 2018; Kiwi Coast 2020)

4.6.3 Control

- Establish a comprehensive trap network first, then refine placement as operational hotspots become apparent.
- Concentrate trapping along likely movement routes, particularly waterways and other natural travel corridors, rather than following arbitrary grid layouts.
- Capture data shows more than 90% of stoat captures occurred within 100 m of the coast or waterways on Waiheke (Te Korowai o Waiheke, 2023).
- Experienced trappers or detection dog teams can substantially improve trap performance by identifying likely travel routes to place traps.
- Devices should not be removed simply because catches decline, as every remaining individual still requires an opportunity to encounter a trap.
- Trap servicing should be based on bait condition and capture probability rather than fixed calendar intervals.
- One operational programme used approximately 1 trap per 6 ha (200–250 m spacing) before adding additional traps around identified hotspots for stoats.
- The same programme increased servicing from monthly to weekly for high-probability traps during summer, while maintaining fortnightly servicing elsewhere after finding monthly servicing inadequate.
- Raising DOC200 traps approximately 10 cm may reduce hedgehog interference while maintaining stoat captures.

Trusted control tools

- DOC200 traps, particularly double-set wooden designs.
- Raised DOC200 traps (approximately 10 cm) to reduce hedgehog interference.
- Live-capture traps
- ZIPIN traps.
- Low-density PAPP sowing (example given of Fiordland).
- PAPP sausage baits were identified by one researcher as having considerable future potential.

- Mouse-oil lure (Connovation) was reported by one interviewee to perform well for stoats, weasels and mice.

Limitations or issues

- Plastic Trapinator traps (one project).
- Podi traps were difficult to set reliably on steep terrain.
- One project found A24s ineffective for stoats.
- Weasels were considered too light to reliably trigger some trap designs.

Research Findings

- Mustelid control generally needs to be continuous, or at least annual, and implemented over large areas because stoats and ferrets have large home ranges, high reproductive potential, rapid reinvasion, and juvenile dispersal distances up to 45 km (National Pest Control Agencies 2018; Brown et al. 2015; Brown et al. 2017).
- Mustelid kill traps should be placed in tunnels or covers to orient animals, protect traps, reduce non-target captures and disguise the trap. Tunnel design should include double baffles, suitable entry holes, see-through ends, removable roofs and secured bait. Guidance includes tunnels at least 600 mm long, or 950 mm where weka are present, with entry holes around 75 mm for ferrets and 50 mm for stoats (National Pest Control Agencies 2018).
- Trap-site micro-placement should prioritise likely mustelid travel or hunting routes, including dry rabbit country, barns with mice, offal pits with rats, dams and creeks, country roads, creek edges, tracks, drainpipes, culverts, vegetation edges, bridges, banks, rabbit holes, possum dens, lone trees and gateposts. Trap spacing should be intensified to around 50 m at hotspots, good habitat or high-catch areas (National Pest Control Agencies 2018).
- Permanent trap sites are preferred for mustelid control, with 10 days an absolute minimum (National Pest Control Agencies 2018; National Pest Control Agencies 2015).
- Non-target species can substantially reduce mustelid trapping efficiency by consuming bait or triggering traps. Trap tunnels, entrance restrictions, trap orientation and species-appropriate trigger settings should therefore be used to minimise non-target interference (National Pest Control Agencies 2018; Gormley & Warburton 2020).
- Fresh meat lures generally outperform processed products for stoats and ferrets. Rabbit is consistently effective where available, while eggs, rabbit-based products, fish and other meat lures provide useful alternatives depending on local conditions and seasonal prey availability (National Pest Control Agencies 2018; Predator Free New Zealand Trust 2025; Kiwi Coast 2020).
- Trap performance should be monitored continuously. Consistently unproductive trap sites should be relocated, while locations that repeatedly capture stoats or ferrets should be retained and, where appropriate, reinforced with additional traps (National Pest Control Agencies 2018; Predator Free New Zealand Trust 2025; Gormley & Warburton 2020).

Stoats

- For stoats, kill traps generally provide more humane and reliable control than live-capture traps where eradication or sustained suppression is the objective. Trap selection should prioritise proven capture efficiency and animal welfare performance (National Pest Control Agencies 2018; National Pest Control Agencies 2015).

- Self-resetting traps have potential to reduce servicing requirements for stoat control, but operational deployment should account for reset reliability, lure longevity and ongoing maintenance requirements (Brown et al. 2015).
- For stoats, trap networks should follow natural movement features such as habitat perimeters, ridges, tracks, roads, altitude contours, waterways and access routes. Traps should be set on both sides of large rivers and across available habitats because individual stoats may not use all habitats (National Pest Control Agencies 2018).
- Stoat trap spacing should ensure at least one trap station occurs within each home range. Common broad-scale guidance is traplines no more than 800 m–1 km apart with traps 100–200 m apart, while intensive operations may use 100 m trap spacing and high-value objectives such as kiwi translocation may require about 500 m between traplines and 100 m between traps (National Pest Control Agencies 2018; Predator Free New Zealand Trust 2025; Department of Conservation 2019).
- For stoats, traps generally do not need to be denser than about one per 5–7 ha, but more widely spaced traps need to remain set for longer to allow all stoats to encounter them. In Northland kiwi zones, typical stoat trap density has been about one trap per 10 ha, with lower density in extensive grassland and higher density in continuous forest or complex terrain (National Pest Control Agencies 2015; Kiwi Coast 2020).
- Stoat trap density should be increased along coastlines and waterways where surveillance demonstrated substantially higher capture rates (Te Korowai o Waiheke 2023).
- Trap presentation can influence stoat capture success independently of lure choice. Tunnel configuration, trap orientation, entry-hole size, visual presentation and ease of access should therefore be considered operational variables and refined where capture or interaction rates are poor (National Pest Control Agencies 2015).
- PVC trap extruders reduced stoat captures and were replaced with mesh designs that maintained non-target protection while improving trap accessibility (Te Korowai o Waiheke 2023).
- Eradication programmes should anticipate behavioural and design-related barriers to capture because some stoats may avoid particular tunnel types or fail to encounter traps despite planned coverage. Using multiple tunnel designs, sufficient trap density and adaptive trap placement can reduce the risk that survivors remain outside effective capture risk (McMurtrie et al. 2011).
- For stoats, pre-feeding or pre-baiting traps before setting can reduce neophobia and improve initial capture rates, particularly where trapping is newly established (National Pest Control Agencies 2015; Brown et al. 2015).
- For stoats, lure choice should be treated as an adaptive operational variable because lure attractiveness changes with season, prey availability and individual behaviour. Using a variety of lures and changing lure types through time can improve long-term trap interaction (National Pest Control Agencies 2018; Predator Free New Zealand Trust 2025; Brown et al. 2015).
- Fresh rabbit replaced Erayz lure where climatic conditions reduced lure longevity and improved operational performance (Te Korowai o Waiheke 2023).
- Winter servicing intervals were shortened where lure longevity declined under seasonal conditions (Te Korowai o Waiheke 2023).
- Long-term stoat trapping alone can become less effective because of trap- or lure-shy animals. Programmes should periodically vary bait types, pulse fresh baits, use double traps where

appropriate, and consider secondary-poisoning pulses to remove otherwise untrappable stoats (Kiwi Coast 2020).

- For stoats, periods of abundant prey (particularly following rodent irruptions) can reduce trap interaction because animals are less motivated to investigate lures. Control programmes should anticipate these periods by increasing trapping effort or integrating complementary control methods where appropriate (Brown et al. 2015; Brown et al. 2017).
- PAPP and secondary-poisoning pathways can contribute to stoat control, but should be treated as part of a wider toolset rather than a complete replacement for dedicated stoat management. Hand-laid PAPP trials used non-toxic pre-feed followed by two PAPP deployments one week apart and reduced stoat detections by more than 95% in Fiordland (Department of Conservation 2026; Kiwi Coast 2020).
- Te Korowai o Waiheke intensified trap servicing during stoat denning and dispersal, checking traps within 100 m of the coast and waterways every four working days and checking any trap that caught a juvenile or adult female daily for the following 10 days.

Ferrets

- For ferrets, traps should be concentrated around rabbit burrows, riparian vegetation, streams, ponds, culverts, hedgerows, fences, barns, structures with rodents, fresh kills or scavenged carcasses, roads, bridges and other movement corridors (National Pest Control Agencies 2018; Predator Free New Zealand Trust 2025; Kiwi Coast 2020).
- Ferret trap spacing guidance includes 200–400 m between traps and 1,000 m between traplines, but grid precision is less important than covering ferret habitat and travel routes. High-catch sites should receive additional clustered traps, and a 2–3 km buffer beyond the control area can help defend against reinvading ferrets (National Pest Control Agencies 2018; Predator Free New Zealand Trust 2025).
- Ferret control is best targeted from late summer through autumn, after juveniles have settled, to reduce reinvasion by dispersing juveniles (National Pest Control Agencies 2018).
- Ferrets can be difficult to trap in winter and female ferrets can be difficult to trap during the breeding season. Leaving traps and bait stations in place continuously may partly reduce avoidance of new objects, but targeting breeding females remains difficult (National Pest Control Agencies 2018).

Weasels

- Weasel control should not assume stoat or ferret grids are adequate. Weasels have smaller home ranges, different behaviour and habitat use and may require spacing closer to a rat trapping grid. Trigger weights also need to be lighter where weasels are targeted (National Pest Control Agencies 2018; Predator Free New Zealand Trust 2025).

4.7 Possums

4.7.1 Ecology and operational considerations

- Interviewees described possums as highly variable in their behaviour, particularly at low density.
- Several interviewees noted that while some surviving possums remain within small refuges, others travel long distances searching for other possums, making surveillance requirements difficult to predict.
- One project reported substantially more possums being caught in valleys than on ridges at certain times of year, suggesting seasonal food resources influenced habitat use.
- Several interviewees considered understanding possum distribution before control valuable where it directly influenced operational design and tool deployment.
- Several interviewees emphasised that there will always be some possums that refuse bait regardless of bait type or deployment method.
- Detection dogs were used sequentially through operations: hunting dogs to assess higher-density populations, then scat detection dogs during mop-up.
- Interviewees suggested maintaining a surveillance or control device within each expected possum home range and understanding the associated detection probability.

Research Findings

- As possum density declines, home ranges become larger and increasingly variable among individuals. Eradication and surveillance design should therefore be based on the smallest observed home ranges, or the movement behaviour of the least mobile individuals, rather than average values to ensure all remaining possums encounter monitoring or control devices (Anderson et al. 2022; Rouco et al. 2015).
- Possum density can vary strongly between urban habitat types, with urban forest fragments supporting much higher densities than surrounding residential areas and densities capable of harming native vegetation and wildlife despite periodic control (Patterson et al. 2021).
- Possum trap avoidance may cause density underestimation in highly modified urban residential habitats, so monitoring and density estimates in these settings should be interpreted cautiously (Patterson et al. 2021).
- Habitat-targeted possum control becomes more important during maintenance than during the initial knockdown because habitat preferences become clearer at very low density (Rouco et al. 2015).

4.7.2 Surveillance

- Surveillance commonly became more targeted as possum density declined.
- Detection dogs and scat mapping were repeatedly used to direct surveillance and concentrate control effort.
- Lower-density surveillance networks of cameras were often supplemented with targeted dog surveys, particularly in areas where surveillance coverage was sparse.

- One project historically used wax tags to identify where kill traps should be relocated during mop-up.

Trusted surveillance tools

- Scat detection dogs.
- Wax tags.
- Cameras (although confidence varied between projects).
- Chew cards during initial population assessment.
- Community sightings.

Limitations

- Several interviewees questioned relying on cameras alone for possums.
- One project reported 1 camera per hectare still failed to detect known possums.
- One project found scat dogs performed similarly to cameras, while another considered cameras more effective in their landscape.
- One project replaced wax tags with scat dogs but later questioned whether this improved operational performance.

Research Findings

- For possums, maximising detection probability rather than relying on standard survey designs is important in very low-density populations. This includes increasing the number of monitoring lines and/or extending line length (e.g. 400 m lines with 20 devices) to reduce zero-detection datasets and improve precision (National Pest Control Agencies 2020b; National Pest Control Agencies 2024).
- Repeat monitoring should use the same survey lines to improve long-term trend detection, but monitoring should not occur so frequently that possums become familiar with monitoring devices or monitoring sites (National Pest Control Agencies 2020b).
- If adverse weather substantially suppresses possum activity during monitoring, surveys should be repeated rather than interpreting poor detection as evidence of low abundance (National Pest Control Agencies 2020b).
- Wax tags generally provide greater detection sensitivity than trap-catch monitoring, while wax tags and chew cards perform similarly. Monitoring programmes should maximise sensitivity and minimise false negatives when populations are near elimination (National Pest Control Agencies 2020b).
- Avoid using wax tags, and potentially chew cards, immediately following cyanide paste operations because bait-shy possums may avoid these devices and reduce monitoring sensitivity (National Pest Control Agencies 2020b).
- Three-night deployments of wax tags or chew cards should generally be avoided because they reduce monitoring sensitivity (National Pest Control Agencies 2020b).
- Accurate identification of possum bite marks on wax tags and chew cards is essential. Uncertain bite marks should be independently checked because misclassification can substantially affect interpretation at very low densities (National Pest Control Agencies 2020b).

- Previously captured possums can become trap shy. Cameras therefore provide an important complementary surveillance method (Anderson et al. 2022)
- Thermal cameras consistently detected more possums than chew cards or passive infrared trail cameras, while passive infrared cameras also substantially outperformed chew cards (Ross 2021).
- For possums, cameras should generally be positioned 2–4 m from the target area, and monitoring densities of approximately one camera per 25 ha provide substantially higher detection confidence than wider spacing such as one camera per 50 ha (Ross 2021).
- Long-lasting visual and olfactory lures can substantially increase possum detection on chew cards. Lure-it Spray and Blaze increased detection compared with standard flour/icing sugar lure (70.5% and 62.1% vs 41.0%) and may improve low-density surveillance across chew cards, bait stations, bio-bags and kill traps (Waters et al. 2016).
- Lure-it Spray and Blaze also reduced rat interference with chew cards compared with flour/icing sugar lures, improving the sensitivity of possum detection. Cinnamon and aniseed formulations did not differ in possum detection (Waters et al. 2016).

4.7.3 Control

- Control commonly progressed from broad knockdown methods to increasingly targeted approaches as populations declined.
- Interviewees frequently combined broad-scale toxin use with trapping and dog-directed control during later stages.
- One programme transitioned from night hunting, to leg-hold trapping followed by targeted kill traps as density declined.
- The same programme continued night hunting until catches declined to approximately 15 possums per night before shifting to intensive leg-hold trapping.
- The type of trap is less important than good trap placement in possum movement areas.
- Highly attractive focal sites ("possum nightclubs") should be considered during repeatedly attract surviving possums to known locations with pre-baiting and then opening 4-6 traps simultaneously to remove many possums at once.

Trusted control tools

- Leg-hold traps.
- Cage traps.
- Ferratox.
- Brodifacoum.
- Double Tap.
- AT220s.
- Detection dogs directing targeted control after knockdown.
- Combination of Brodifacoum bait stations and AT220s at appropriate densities.

Limitations or issues reported

- Zip wireless leg-holds (one project).
- A24s (reported by more than one operational interviewee).
- One project reported approximately 80% failure rates with AT220s despite regular servicing.

Research Findings

- Cage traps achieved higher capture probabilities than both ground and raised leg-hold traps for possums under the conditions tested (Anderson et al. 2022).
- Small improvements in trap performance become increasingly important at low density because they substantially increase the probability that every remaining possum encounters a trap (Anderson et al. 2022).
- A cereal-then-peanut butter paste dual-1080 regime has potential to locally eliminate possums and is best suited to relatively small-scale ground-based mop-up, with aerial cereal bait followed by hand-laid peanut butter paste for survivors. (Nugent et al. 2020)

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5 Last individuals

5.1 Core message

Interviewees consistently identified removing the last individuals as one of the greatest technical challenges in mainland elimination. Most considered the final phase to require a fundamentally different approach from the initial knockdown, multiple complementary tools are needed, surveillance should become increasingly targeted, and programmes must adapt to the behaviour of the remaining animals.

Interviewees differed on whether remaining animals become genuinely trap shy or simply difficult to encounter because of low density. There was also uncertainty about how much effort should be invested in individual animals versus waiting for growing numbers to become detectable, when to transition to mop-up strategies, how to distinguish surviving animals from reinvaders, and which emerging tools are most likely to improve the efficiency of removing the final survivors. Interviewees identified major knowledge gaps around the behaviour, detectability and movement of the final individuals as being prohibitive to effective operations.

5.2 Different strategies

Strength of support: Very strong (approximately 80% of interviews discussing last individuals; represented across Researchers, Technical Experts, Project Managers, Operational Staff and Strategic Experts).

A recurring message was that the final 2–5% of animals should not be treated as the final stage of the knockdown. Interviewees consistently described the need for a dedicated mop-up phase with different objectives, tools and decision-making. The common narrative was that the focus shifts from reducing a population to locating and removing individual animals, often requiring more time and effort than expected. One project moved from weekly servicing and broad knockdown to hotspot-based responses where device type, lure, servicing frequency and monitoring intensity were adjusted to remaining activity. Several argued that programme design should anticipate this transition by defining the objectives, surveillance methods, control tools and decision criteria of different phases before implementation begins. One key statement was to treat the final individuals as an intelligence and surveillance problem rather than a trapping problem alone.

Research Findings

- The final stages of elimination require a different strategy from initial population reduction. Strategies targeting the "average" individual will fail to remove rogues and trap-recalcitrant individuals. Management should instead target the full range of behavioural types within the population and account for density-dependent changes in behaviour as individuals are removed (Garvey et al. 2020).
- The remaining possums following intensive control were predominantly resident survivors rather than reinvading animals. Reliance on a single control method is therefore unlikely to remove the

final individuals, and adaptive strategies targeting behavioural variation are required as catches approach zero (Johnstone et al. 2024).
- Moving from the initial knockdown phase to mop-up required a change in trapping strategy. The programme shifted from predominantly cage trapping to targeted leg-hold trapping, burying leg-hold traps at locations of feral cats captured on camera. This approach was reported to be achieving success with the remaining animals (Tu Mai Taonga, 2024).

5.3 Variety of tools

Strength of support: Very strong (approximately 75% of interviews discussing last individuals; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Many interviewees emphasised that no single tool is sufficient for removing the last individuals. Instead, success depends on combining complementary detection and control methods and adapting them as the operation progresses. Detection dogs, cameras, traps, bait stations, community reports and targeted surveillance were all commonly described as components of an integrated approach. Several interviewees also described rotating lures, changing bait types, introducing different devices or moving traps to maintain effectiveness, cautioning against relying on one device or lure throughout the programme.

Operational examples included:

- Rat detection dogs becoming the primary tool for locating the final rats.
- Hunting dogs used initially to locate possum hotspots before scat dogs guided mop-up.
- Wax tags used to identify where possum kill traps should be located.
- Camera detections directing trap placement for cats.
- Auto-traps and multi-species devices (e.g. AT220s and DOC200s) reducing servicing demands while maintaining coverage.
- Switching to social lures at low densities because animals become increasingly interested in looking for conspecifics at low densities.

Research Findings

- Using multiple cues increases the likelihood of targeting the full range of behavioural types within a population (Garvey et al. 2020).
- Using multiple complementary surveillance methods with spatial replication reduces false negatives compared with relying on a single detection method (Gormley et al. 2011).
- Detection systems should combine multiple complementary methods because no single surveillance tool is sufficiently reliable to demonstrate eradication (Griffiths et al., 2014).
- Introducing alternative control devices can improve removal of surviving individuals. Leg-hold traps were introduced specifically to target possums unwilling to enter cage or kill traps, while varying lure types (including curry powder, Nutella, aniseed lure, social lures and long-lasting Motolures), trap appearance and trigger mechanisms may improve capture of individuals that avoid one device but remain susceptible to another (Johnstone et al. 2024).

- Combining kill traps, chew cards, cameras and live trapping provided complementary evidence that possum abundance had declined by more than 95% (Johnstone et al. 2024).

5.4 Targeted surveillance

Strength of support: Strong (approximately 65% of interviews discussing last individuals; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Several interviewees described surveillance becoming progressively more targeted as populations declined. Rather than maintaining uniform grids, projects increasingly concentrated effort where evidence suggested animals remained. Surveillance was commonly redirected towards historical hotspots, likely reinvasion pathways and habitats where previous detections had occurred, while effort was reduced in areas with consistently no detections. One technical expert also suggested that, where the risk of rapid population recovery was low, delaying an immediate response to an isolated detection could allow the remaining rat to move more widely and become easier to locate before targeted removal.

Research Findings

- Habitat suitability models can be used to stratify surveillance according to predicted occupancy and distinguish current from potential distributions (Gormley et al. 2011).
- Surveillance objectives should determine how effort is allocated. Where the objective is detecting new incursions or range expansion, proportionally greater survey effort should be directed towards lower suitability areas beyond the current distribution rather than concentrating only on areas of highest occupancy (Gormley et al. 2011).
- Surveillance should be designed to detect surviving animals rapidly enough that they can be removed before breeding occurs (Griffiths et al., 2014).
- Camera networks should be sufficiently dense to provide confidence that all remaining individuals have an opportunity to be detected (DOC, 2021).
- GPS tracking of search effort allows surveillance coverage to be mapped, gaps identified and future searches targeted more effectively (Griffiths et al., 2014).
- Surveillance data should be used to inform operational decisions continuously throughout implementation rather than being collected solely for reporting or programme evaluation (Predator Free Wellington, 2024).
- Daily review of surveillance data allowed operational priorities to be updated continuously, including identifying hotspots, prioritising servicing and directing response teams (Predator Free Wellington, 2024).
- Detecting the location of remaining animals allows toxin and control tools to be applied selectively rather than uniformly across the landscape as populations decline (Bell & Bramley, 2008).
- Trail cameras were used to estimate the number of remaining feral cats, identify individual movement patterns and direct targeted mop-up operations, rather than simply confirming presence or absence (Tu Mai Taonga, 2024).

5.5 Animal behaviour

Strength of support: Strong (approximately 65% of interviews discussing last individuals; represented across Researchers, Technical Experts and Operational Staff).

Interviewees consistently reported that the remaining animals behave differently from the initial population. Larger home ranges, altered movement patterns, neophobia, trap or bait avoidance and increased individual variation were all described as making the final animals more difficult to detect and remove. Several projects deliberately changed their approach at low densities by treating each remaining animal as an individual rather than part of a population. Interviewees also suggested that low-density animals may become increasingly motivated to locate conspecifics, creating opportunities to develop social or behavioural lures in addition to traditional food-based attractants.

Some observations included:

- Older and breeding feral cats becoming increasingly difficult to trap.
- Some possums expanding movements at low density while others remained within small refuges.
- Rats increasing home-range size after knockdown, making surveillance systems unreliable.
- Remaining animals becoming more difficult to detect because of low encounter rates rather than true trap shyness.
- One operational interviewee did not believe “trap-shy” possums existed, arguing persistence eventually resulted in capture.

Research Findings

- Individual behavioural differences should be explicitly incorporated into pest management. Responses to control are influenced by age, sex, reproductive status, body condition, experience and personality. Previous aversive experiences can produce trap-shyness, while repeated exposure without consequence can lead to habituation (Garvey et al. 2020; Johnstone et al. 2024).
- As populations approach elimination, management should place less emphasis on food lures and greater emphasis on safety cues by positioning devices where animals perceive them to be safe. Missed opportunities can be reduced by deploying social lures (e.g. conspecific pheromones) when densities are low and animals are seeking mates, and by using inconspicuous traps presented at the scale of the home ranges of shy individuals (Garvey et al. 2020).
- Intensive trapping selected for increasingly shy and trap-recalcitrant possums. Possums captured late in the operation were significantly less bold than those captured before control began, and responses to novel devices differed among personality types, indicating that different devices target different behavioural phenotypes (Johnstone et al. 2024).

5.6 When to mop-up

Strength of support: Moderate (approximately 50% of interviews discussing last individuals; represented across Project Managers, Researchers and Operational Staff).

Interviewees consistently recognised that the broad-scale knockdown and mop-up phases require different objectives and methods, but there was little agreement on when to transition between them and no consistent thresholds or decision framework were identified across projects. Projects described using practical indicators such as declining capture rates, increasingly localised detections, reduced bait take or evidence that only isolated individuals remained before shifting to targeted surveillance and control. Several interviewees also noted that transition criteria evolved through experience, and more than one project had adapted their mop-up criteria due to limiting performance.

Examples included:

- Declining nightly possum catches during night hunting.
- Repeated detection-free periods.
- Reduced wax tag interference.
- Reduced dog detections.
- Trap-catch rates reaching levels where broad-scale control became inefficient.

5.7 New approaches

Strength of support: Moderate (approximately 45% of interviews discussing last individuals; represented across Researchers, Technical Experts and Project Managers).

Interviewees repeatedly identified targeting the final individuals as the area where innovation is most needed. Developing tools specifically for the final 2-5% rather than adapting knockdown tools was identified as important.

Suggested priorities included:

- Trials of social lures and scent cues for low-density animals.
- Multi-species devices that reduce servicing effort.
- Methods for distinguishing survivors from reinvaders.
- Improved detection dog applications.
- AI-assisted surveillance.
- Trials specifically designed to improve mop-up rather than knockdown.
- Better understanding of animal behaviour once populations reach very low densities.

Research Findings

- Trap-recalcitrant survivors remain a major barrier to mainland eradication. Until these individuals can be effectively detected and removed, successful eradication of possums and other invasive mammals relying on trapping is unlikely to be achieved (Johnstone et al. 2024).

5.8 Additional Comments

- Treat every remaining animal as an individual rather than part of a population.
- Use social cues rather than food lures for low-density animals.
- Use dye markers to identify whether animals have interacted with bait (reinvaders versus survivors).
- Use modelling tools to estimate the probability that a captured animal is the last remaining individual.
- Community sightings are a valuable tool during the detect-and-respond phase for stoats and possums.
- Allow isolated rats to become detectable before responding where risk is low.

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6 Proving absence

6.1 Core message

Interviewees consistently identified proving absence as one of the greatest unresolved challenges of mainland elimination. There was broad agreement that no universally accepted framework currently exists, and that confidence in absence is built from multiple lines of evidence rather than a single threshold or survey. While proof-of-absence modelling was widely recognised as the best available analytical framework, operational projects generally relied on practical surveillance systems, repeated detection-free periods and informed judgement to decide when confidence was sufficient.

Interviewees identified continuing uncertainty around the surveillance effort required for different species and landscapes, how reinvasion should be incorporated into proof-of-absence frameworks, how best to integrate modelling with operational judgement, and whether nationally consistent criteria for declaring elimination are realistic.

6.2 No agreed standard

Strength of support: Very strong (approximately 75% of interviews discussing proving absence; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Interviewees consistently reported that there is no agreed standard for demonstrating elimination on the mainland. Projects differed both in how they defined elimination and in the level of evidence considered sufficient to declare success. Some described elimination as a state where the core area is effectively clear but occasional reinvaders are expected, meaning a low level of ongoing detections is acceptable. Others considered elimination to require a defined period with no detections under a known level of surveillance effort.

Several interviewees emphasised that any declaration of elimination should clearly specify the surveillance methods, intensity and spatial coverage used to support that conclusion. However, there was no consistent view on how much surveillance was sufficient or how long an area should remain detection-free before transitioning from active elimination to long-term surveillance and biosecurity.

Research Findings

- Absence cannot be inferred from non-detection. Demonstrating eradication requires estimating the probability of freedom while explicitly accounting for imperfect detection and the possibility that individuals remain undetected (Anderson et al. 2022; Gormley et al. 2021). Confidence in absence increases with repeated non-detection and depends on prior probability, surveillance effort and detection probability (Wood et al. 2024).
- Programmes aiming to demonstrate pest freedom should use surveillance designed to provide evidence of absence rather than relying on failure to detect animals (Warburton & Livingstone 2015, Griffiths et al. 2014).
- Declaring eradication requires an explicit probability-of-freedom threshold. The stopping threshold should balance the costs of continued surveillance against the consequences of

incorrectly declaring eradication and should be set higher where the consequences of survivor persistence are greatest (Anderson et al. 2017; Anderson et al. 2022; Gormley et al. 2011).

- Acceptable probability thresholds may differ among programmes depending on the consequences of making an incorrect declaration (Anderson et al. 2017; Anderson et al. 2022). The target probability of absence should be determined by balancing the risk of declaring absence too early against the cost of additional surveillance. If the agreed threshold is not achieved, additional surveillance should continue until it is reached (Wood et al. 2024).
- The balance between immigration and removal determines whether a programme functions as eradication, elimination or suppression (Russell 2025).
- Elimination may be operationally defined as no detections above an agreed confidence threshold (e.g. >95%), with eradication declared only after an additional period equivalent to a breeding cycle has elapsed (Russell 2025).

6.3 Multiple lines of evidence

Strength of support: Very strong (approximately 75% of interviews discussing proving absence; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Interviewees consistently rejected relying on a single tool or absence of detections. Instead, projects combined multiple sources of evidence including cameras, chew cards, wax tags, traps, detection dogs, community reports, historical detection patterns, neighbouring block status and surveillence of reinvasion pathways. Several interviewees also noted that surveillance tools perform differently between sites, meaning apparent absence may reflect the limitations of a particular device. Combining independent sources of evidence was therefore considered essential for building confidence in absence.

Operational examples included:

- One project based confidence on the agreement between scat detection dogs, camera networks and repeated detection-free periods, rather than accepting any one method in isolation.
- One programme interpreted detections alongside the status of neighbouring operational blocks, using surrounding surveillance results to judge whether a detection was more likely to represent reinvasion or a surviving animal.
- More than one project deliberately interpreted detections in the context of animal age, sex and location, treating isolated juvenile male possums near boundaries differently from repeated detections or animals deeper within the elimination area.
- One operational programme combined historical hotspot maps, current surveillance results and known reinvasion pathways to decide where additional surveillance or response was required rather than treating all non-detections equally.
- One project found wax tags outperformed chew cards at one site, while chew cards performed better less than a kilometer away for ship rats, demonstrating that confidence should not be based on a single surveillance method even within the same landscape.

Research Findings

- Confidence in eradication should be built from multiple lines of evidence. Detection probability can be estimated using multiple data sources, and surveillance sensitivity can be increased by combining complementary methods (Anderson et al. 2017; Anderson et al. 2022; Gormley et al. 2011).
- Although individual methods have imperfect detection, combining multiple survey methods can produce very high overall detection probabilities (Gormley et al. 2011).
- Combining multiple survey methods with repeated spatial sampling substantially reduces false negatives (Gormley et al. 2011).
- Surveillance systems should combine multiple independent detection methods because no single surveillance tool provides sufficient confidence to declare eradication (Griffiths et al., 2014).
- Trap catches approaching zero should not be interpreted as elimination. Independent surveillance should continue because trail cameras continued detecting possums after trap catches had effectively ceased (Johnstone et al. 2024).
- Combining kill traps, chew cards, cameras and live trapping provided complementary evidence that possum abundance had declined by more than 95% (Johnstone et al. 2024).
- Predator Free Wellington (2024) used trail cameras, chew cards, bait stations, traps, detection dogs and public reports together because no single method was considered sufficient to demonstrate proof of freedom.
- Rangitoto-Motutapu similarly used spotlighting, traps, indicator dogs, sign searches and tracking devices (Griffiths et al., 2014).

6.4 Adapting surveillance to build confidence

Strength of support: Strong (approximately 65% of interviews discussing proving absence; represented across Project Managers, Operational Staff, Technical Experts and Researchers).

Interviewees consistently described surveillance as an adaptive process rather than maintaining the same monitoring system throughout a programme. As confidence increased, projects progressively reduced or retargeted surveillance, concentrating effort where uncertainty remained highest while maintaining sufficient coverage to detect survivors or reinvaders. Decisions were generally based on previous detections, reinvasion risk, historical hotspots and operational objectives rather than following fixed surveillance schedules. Some interviewees reported operational areas that received little or no ongoing surveillance because resources were directed towards continued elimination elsewhere. This reflected a strategic decision to prioritise expansion over maintaining intensive surveillance everywhere simultaneously, although interviewees acknowledged this reduced confidence in absence within those areas.

Operational examples included:

- One project progressively shifted from high-density camera networks during knockdown to surveillance focused on historical hotspots, reinvasion pathways and recent detections.

- One programme developed four surveillance risk categories, with recently cleared areas monitored at approximately 1 device per hectare and frequent dog surveys, while long-quiet areas were monitored at approximately 1 device per 10 ha, supplemented by community reporting and periodic dog surveys.
- One project deliberately reduced surveillance from 1 camera per hectare to 1 camera per 5 ha, which resulted in a rat breeding event across approximately 40 ha. The programme subsequently reinstated higher surveillance intensity, illustrating the consequences of reducing surveillance too early.
- One possum programme reduced surveillance from approximately 1 camera per 10 ha to 1 per 80 ha after around 80 days without detections, while continuing targeted dog surveys in higher-risk areas.
- One project only monitored locations where a detection would trigger a management response, choosing not to maintain dedicated surveillance within areas already protected by permanent toxin control for rats.

Research Findings

- Quantitative proof-of-absence frameworks provide an objective basis for designing these surveillance programmes (Samaniego-Herrera et al. 2013; Anderson et al. 2017).
- Surveillance effort should reflect surveillance objectives. Where the objective is detecting new incursions or range expansion, survey effort should be concentrated in suitable habitat outside the current distribution rather than only in areas of highest occupancy (Gormley et al. 2011).
- Risk-based surveillance should concentrate effort where the target is most likely to occur. Where empirical data are limited, local expert knowledge should inform surveillance design (Wood et al. 2024).
- Surveillance design should incorporate optimisation of detection-device spacing. Simulations showed confidence in eradication of rodents increased as device spacing decreased from 60 m to 10 m, with spacings <60 m capable of achieving >90% confidence immediately after eradication under the simulated scenarios (Russell et al. 2017).
- Immediate post-eradication surveillance is preferable to prolonged waiting periods because it can detect survivors while populations remain small, distinguish survivors from reinvaders, optimise follow-up surveillance, accelerate restoration, and avoid unnecessary delays associated with traditional waiting periods before declaring eradication (Samaniego-Herrera et al. 2013; Anderson et al. 2017; Anderson et al. 2022).
- Intensive post-operational surveillance should commence immediately following knockdown and continue until confidence in eradication has been established (Speedy et al. 2007).
- Wax tags deployed at approximately 50 m spacing immediately after aerial baiting for ship rats could have provided strong evidence of eradication success without requiring prolonged follow-up surveys (Samaniego-Herrera et al. 2013).
- Predator management should account for delayed responses. Secondary poisoning removed all detected resident stoats from the study area following an aerial 1080 operation, but reinvasion occurred the following summer after seven months with no detections, demonstrating the need for continued surveillance after apparent elimination (Nichols et al. 2022).

6.5 Proof-of-absence modelling

Strength of support: Strong (approximately 60% of interviews discussing proving absence; represented primarily across Researchers and Technical Experts).

Researchers generally viewed proof-of-absence modelling as the strongest available framework for designing surveillance and estimating confidence, though it was not commonly used among interviewees. Researchers described using models to plan device networks, estimate the probability that a captured animal was the last remaining individual, and determine how much surveillance is required to achieve specified confidence. However, several limitations were also identified.

Examples included:

- Uncertainty over incorporating detection dog survey data.
- Dependence on closed-population assumptions despite ongoing reinvasion.
- Large surveillance requirements before models become informative.
- Declining confidence where model outputs conflicted with field observations.
- Reduced trust once low-density home-range expansion violated model assumptions.
- Uncertainty over the role of POA modelling in proving elimination

Research Findings

- Quantitative proof-of-absence should be incorporated during eradication planning rather than after operations have finished because the surveillance design and operational data required for proof of absence must be collected throughout the programme (Samaniego-Herrera et al. 2013; Anderson et al. 2017).
- Broadscale eradication should be assessed using a two-stage proof-of-absence framework (Anderson et al. 2017; Anderson et al. 2022).
- Local knowledge, expert judgement, previous surveillance and empirical data can all contribute to specifying prior probability within Bayesian proof-of-absence frameworks (Wood et al. 2024).
- Detection network design and proof-of-absence modelling should be based on empirical estimates of movement (Nathan et al. 2025).
- Quantitative proof-of-absence models support adaptive management by identifying cost-efficient surveillance strategies, estimating the surveillance effort required to achieve an agreed probability of eradication, guiding resource allocation across management zones, and informing decisions about when eradication can be declared (Anderson et al. 2017; Anderson et al. 2022).
- Aerial baiting alone provides no information about whether eradication has been achieved or where survivors remain. Spatial proof-of-absence models can estimate the probability of eradication within weeks rather than years, identify where survivors are most likely to persist, optimise follow-up surveillance, and estimate the probability of eradication exceeding 99% after two surveys with no detections (Samaniego-Herrera et al. 2013).
- GPS tracks from hunters, detector dogs and other surveillance teams can be converted into point detections and incorporated directly into spatial proof-of-absence models (Gormley et al. 2021).

- Surveillance data should be partitioned into discrete survey sessions (e.g. monthly or annually) so probability of freedom can be updated sequentially as new surveillance information becomes available (Anderson et al. 2017; Gormley et al. 2021).
- Simulations indicated that approximately 15–20 nights of surveillance for invasive rodents provided most of the gain in confidence, while monitoring beyond about 20 nights provided little additional benefit. ≥10 consecutive nights of monitoring immediately after eradication could achieve high confidence under appropriate surveillance spacing (Russell et al. 2017).
- Declaring all management zones free does not necessarily demonstrate eradication across the entire operational area because each zone has some probability of being incorrectly declared free. Broadscale confidence should therefore account for cumulative uncertainty across management zones (Anderson et al. 2017).

6.6 Confidence in absence

Strength of support: Moderate (approximately 50% of interviews discussing proving absence; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Interviewees consistently recognised that demonstrating absence is ultimately a management decision made under uncertainty rather than one based on absolute certainty. One emphasised that the level of confidence required should reflect the consequences of being wrong. Surveillance effort and operational responses should therefore be proportional to the risk posed by undetected survivors or reinvasion. While researchers generally favoured quantitative approaches to estimating confidence, several operational interviewees considered repeated periods without detections easier to interpret in practice, provided surveillance intensity and device performance were well understood.

Operational examples included:

- One researcher contrasted two strategies: invest in a very dense detection network and respond immediately or accept fewer devices and potentially greater effort removing animals later.
- One project accepted occasional detections because response was straightforward and inexpensive.
- Several interviewees stressed the importance of knowing the detection probability of every surveillance device and maintaining devices so they continued operating at that expected performance.

Research Findings

- Confidence in eradication should increase progressively as surveillance accumulates. If surviving individuals remain, populations are expected to increase and become easier to detect over time, so years without detections increase confidence only when supported by ongoing surveillance (Anderson et al. 2017; Anderson et al. 2022).
- Long periods without detections alone are insufficient to declare eradication. In the nutria case study, no detections since 2015 still did not provide sufficient confidence to withdraw financial support until the agreed probability-of-eradication threshold was reached (Anderson et al. 2022).

- Confidence in eradication should be based on species detectability, search intensity, time since the last detection and cumulative surveillance effort (Griffiths et al. 2014).
- Once intensive control has ceased, low-cost, wide spatial surveillance (e.g. low-intensity surveys and public reporting) becomes increasingly important for maintaining confidence in eradication. Increasing investment in public surveillance can accelerate achievement of eradication thresholds (Anderson et al. 2022).
- Establish a formal transition or "success check" between operational completion and declaration of eradication to independently evaluate surveillance performance and residual risk (Lord Howe Island Board, 2025).
- Do not prematurely declare eradication success when populations have only been reduced to very low or undetectable densities, as surviving animals may persist for extended periods before detection (Lord Howe Island Board, 2025).

6.7 Additional Comments

- Challenge the public to report any remaining animals as an additional proof-of-absence tool.
- Delay responses to isolated detections where response costs are low and ongoing surveillance is already in place.
- Separate proof of absence from proof of elimination where continual reinvasion is expected.
- Ignore confirmed reinvaders in proof-of-absence models where immigration can be demonstrated independently.
- Use surveillance only where a detection would trigger a management response.
- Consider elimination as a continuum of increasing confidence rather than a single declaration.

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7 Buffers and reinvasion

7.1 Core message

Reinvasion remained one of the most consistently discussed challenges across interviews. Long-term success depends not only on removing animals, but on designing operational systems that can continually defend against reinvasion.

Interviewees differed on whether rolling-front elimination or whole-landscape elimination provides the most robust long-term strategy, with opinions largely reflecting landscape characteristics and species ecology. There was also uncertainty around how much effort should be invested in external buffers versus surveillance within elimination areas, how reinvasion should be incorporated into proof-of-absence frameworks, and when elimination becomes operationally distinct from sustained suppression.

7.2 Feasible defense

Strength of support: Very strong (approximately 80% of interviews discussing barriers and reinvasion; represented across Researchers, Technical Experts, Strategic Experts, Project Managers and Operational Staff).

Many interviewees argued that aiming for zero has little value if populations rapidly re-establish through reinvasion. Several questioned whether elimination is meaningfully different from suppression unless reinvasion can be prevented or managed effectively. Others viewed elimination as a stepping-stone towards broader eradication, where maintaining a defensible core enables progressive expansion into the surrounding landscape while previously cleared areas continue to be protected from reinvasion.

Research Findings

- Undertake feasibility studies before implementation to test technical feasibility, social acceptability, legal requirements and operational practicality before committing to eradication (Griffiths et al., 2014).
- Biosecurity should be planned and resourced from the outset of a programme (Lord Howe Island Board, 2025).
- Biosecurity systems should include prevention, surveillance, early detection and rapid response as complementary components of a permanent programme (Lord Howe Island Board, 2025).
- Whether management constitutes eradication or ongoing control depends primarily on the effectiveness of the barrier preventing reinvasion and the reinvasion pressure (Russell & Broome 2016).
- Pest-proof fencing was identified as the only effective method of preventing continual reinvasion by ship rats under the mainland landscape conditions studied (King et al. 2011).
- Occasional incursions and breeding events should be expected even within fenced ecosanctuaries (Nathan et al. 2025).

- Important knowledge gaps limiting reinvasion management include dispersal, settlement behaviour, detectability at low densities, density-dependent responses to control, disease transmission in recolonising populations, distinguishing immigration from in situ breeding, environmental modification by invaders, and field validation of predictive models (Byrom et al. 2015; Cowan 2000; Banks et al. 2018; King et al. 2011).

7.3 Reduce reinvasion pressure

Strength of support: Strong (approximately 70% of interviews discussing barriers and reinvasion; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Interviewees consistently described buffers as suppression systems that reduce the likelihood of animals reaching an elimination area rather than impermeable barriers. Many emphasised that some reinvasion should be expected, making surveillance and rapid response essential components of any buffer strategy. Several interviewees also noted that elimination projects should ultimately be judged on the ability to detect and remove reinvaders rather than on preventing every incursion. Several projects also distinguished between buffer performance and elimination success, reporting progress using metrics from the core area while using the buffer to absorb reinvasion pressure. One project described the buffer as a community-managed suppression zone protecting an elimination core managed by dedicated staff. Another was trialing staggered or layered buffer systems to determine whether reinvasion pressure could be reduced before expanding the elimination area.

Research Findings

- Buffer zones reduce reinvasion primarily by reducing the number of dispersers produced rather than intercepting dispersing animals. Early field trials showed substantially slower recovery in 3 km and 7 km buffers than in 1 km buffers, although some dispersing possums moved completely across buffers before settling (Cowan 2000).
- Extending trapping to intermediate stepping-stone islands to reduce reinvasion pressure reduced the likelihood of stoats reaching target islands (Elliott et al. 2010).
- Identifying reinvasion source populations enables targeted pre-emptive control at those sources to reduce reinvasion pressure until landscape-scale eradication becomes possible (Bagasra et al. 2016).
- Predator Free Wellington (2024) maintained an actively controlled virtual buffer ahead of cleared areas to reduce reinvasion pressure while eradication progressed.
- Complete large ground-based toxin operations rapidly across the entire treatment area to minimise reinvasion from surrounding uncontrolled habitat (Kiwi Coast 2020).
- Semi-permeable dispersal barriers alone provide limited benefit. A simulated barrier had minimal effect on possum recovery, whereas reducing surrounding possum populations provided greater benefit. However, surrounding populations needed to be reduced below approximately 2% RTCI before major reductions in reinvasion were predicted (Lustig & Wilson 2020).

7.4 Buffer design

Strength of support: Very strong (approximately 75% of interviews discussing barriers and reinvasion; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

There was broad agreement that no standard buffer design exists. Interviewees consistently described designing buffers around species ecology, dispersal behaviour, habitat, operational capacity and likely invasion pathways rather than applying fixed widths or uniform grids. Projects reported using layered buffer systems that combined natural barriers, suppression zones, defense zones with high detection, and adaptive surveillance focused on hotspots and expected movement corridors. Some projects focused buffer effort predominantly on reinvasion pathways rather than a uniform design. Several researchers recommended designing buffers around the probability of animals encountering and interacting with surveillance or control devices, rather than relying solely on fixed distances.

Interviewees also described trade-offs between buffer width and device density. One suggested that wider buffers could compensate for lower device density, whereas denser device networks may allow narrower buffers. One researcher recommended basing buffer width on the movements of the widest-ranging individuals rather than average home ranges, while others argued that buffers should be designed around the species that is most difficult to manage because of its movement and dispersal behaviour. Natural barriers, low-quality habitat and prey-poor areas were also identified as opportunities to reduce reinvasion pressure where available. Some interviewees noted that small elimination cores are inherently more vulnerable because errors in buffer design have proportionally greater consequences.

Several interviewees also differed on when buffers should be established. Some projects established and operated buffers before attempting elimination within the core, whereas others only implemented or intensified buffers once knockdown was underway or confidence in the core had increased. One operational interviewee reflected that establishing a buffer well ahead of the rolling operational front was inefficient because effort was expended defending areas before they became operationally relevant. Their programme subsequently moved towards buffers that advanced with, or remained closely linked to, the elimination front.

Research Findings

- Collecting site-specific biological information before control improves prediction of recovery rates and maintenance requirements. Predictive models should incorporate local biological information and real landscapes because reinvasion and recovery are highly site-specific (Cowan 2000).
- Larger managed areas recover more slowly and receive proportionally fewer immigrants than smaller areas, making the size and shape of the managed area important considerations when designing reinvasion buffers (Cowan 2000).
- Permanent surveillance should be established immediately at likely reinvasion pathways following eradication (Griffiths et al., 2014).
- Population recovery following control is faster in preferred habitats, particularly forest–pasture margins and small habitat patches with a high proportion of edge habitat (Cowan 2000).

- Buffer effectiveness is determined primarily by buffer width, with possum density and disease prevalence in the source population having secondary effects. Under low-density (2 possums/ha) and low-prevalence (2%) scenarios, buffers ≥2 km were not breached during simulated 4-10 day movements, while 3 km buffers maintained very low incursion probabilities under intermediate-risk scenarios (Byrom et al. 2015).
- Large rivers can impede possum movement and should be incorporated into buffer design where possible. Dispersing possums tended to move along river valleys rather than cross large rivers, whereas forested ridgelines did not appear to influence movement. Natural barriers can be used to focus more intensive control where movements are channeled (Byrom et al. 2015; Cowan 2000).
- Existing operational possum buffer widths in TB management of 5-15 km may be conservative, with modelling suggesting there may be scope to reduce buffer width while maintaining protection against short-term dispersal and exploratory movements (Byrom et al. 2015).
- Coastal areas required wider buffers because they represented important movement corridors for Norway rats (Predator Free Wellington, 2024).
- For mustelids, broad surveillance and rapid response were considered more practical than large preventative buffers because of long-distance dispersal (Predator Free Wellington, 2024).
- Stoat reinvasion is determined more by landscape context than island area alone. Reinvasion was strongly related to nearby mainland coastline, distance from the mainland, and season, with 84% of immigrants captured during autumn and 94% captured on islands less than 304 m offshore (Elliott et al. 2010).
- Predictions of possum reinvasion are highly sensitive to assumptions about edge density and juvenile dispersal, highlighting uncertainty where empirical dispersal data are limited (Lustig & Wilson 2020).

7.5 Reinvaders versus survivors

Strength of support: Strong (approximately 55% of interviews discussing barriers and reinvasion; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Many interviewees highlighted the difficulty of determining whether post-control detections represented reinvading animals or survivors of previous control. This distinction was considered critical because it influences how programme performance is interpreted and whether management should focus on improving elimination methods or strengthening reinvasion barriers. Many projects used detection location, animal age or genetic analyses to help distinguish likely reinvaders from resident survivors. One project identified repeated captures of young males near boundaries as evidence of reinvasion. Another was using DNA analyses of weasels to determine whether animals were residents or immigrants and to identify likely source populations. Some operational interviewees noted that, despite its value for programme evaluation, the operational response often remains the same regardless of an animal’s origin.

Research Findings

- Distinguishing survivors from reinvaders allows programmes to determine whether improvements are required in surveillance, mop-up operations or biosecurity systems (Lord Howe Island Board, 2025).
- Apparent rapid population recovery following control may result from monitoring error, particularly where initial control success is overestimated or monitoring samples different populations from those targeted during maintenance control (Cowan 2000).
- Residual animals and reinvaders may be more difficult to eliminate because behavioural changes (e.g. trap- or bait-shyness) and evolved resistance to control methods can allow populations to re-establish (Banks et al. 2018).
- Collect genetic samples from the original target population before eradication so subsequent detections can be assessed as either survivors or reinvaders (Lord Howe Island Board, 2025).
- Genetic samples should be collected before eradication so that any animals detected subsequently can be identified as either surviving residents or reinvaders (Anderson et al. 2017).
- Genetic comparison of post-eradication detections with the pre-eradication population provides an objective method for evaluating eradication success and biosecurity effectiveness (Lord Howe Island Board, 2025).
- Genetic information can improve interpretation of incursions by distinguishing eradication survivors from multiple independent invasions (Nathan et al. 2025).
- Biomarkers can identify reinvasion pathways and source populations, providing cost-effective information unavailable from conventional surveillance alone and complementing genetic and physical marking methods (Bagasra et al. 2016).
- Genetic analyses can also identify related individuals and family groups, allowing surveillance and control effort to be directed more efficiently (Te Korowai o Waiheke, 2023).

7.6 Adaptive management to reinvasion

Strength of support: Moderate (approximately 50% of interviews discussing barriers and reinvasion; represented across Technical Experts, Project Managers and Operational Staff).

Interviewees commonly described reinvasion management as an adaptive process rather than a fixed design established at the start of a programme. Several projects reported modifying buffer systems as they learned more about reinvasion pathways and animal behaviour. Examples included changing from broad suppression buffers to rolling-front approaches, increasing surveillance and control along active invasion pathways, relocating devices from uniform grids to habitat hotspots, and establishing dedicated defense zones around elimination areas. Other projects trialed community-managed suppression buffers, periodic detection dog surveys, seasonal suppression pulses and modified rabbit fencing to reduce reinvasion pressure while making more efficient use of resources.

Research Findings

- Reinvasion should be assumed and planned for rather than treated as an exceptional event (Lord Howe Island Board, 2025).
- Reinvasion differs fundamentally from initial invasion because source populations, invaded environments and species interactions have changed. Management strategies designed for initial invasion are therefore not necessarily appropriate for reinvasion (Banks et al. 2018).
- Reinvasion management generally requires sustained, lower-intensity surveillance and control over larger spatial scales using cost-effective detection and control tools, rather than rapid intensive responses focused on discrete entry points (Banks et al. 2018).
- Reinvasion management should exploit weaknesses in reinvaders, improve understanding of reinvasion processes, use a broader suite of control options, and suppress reinvaders before they become widespread (Banks et al. 2018).
- Predator Free Wellington (2024) established a dedicated mobile capture team for biosecurity surveillance, detections and incursions rather than combining these tasks with routine servicing.
- Detection events should trigger immediate deployment of additional surveillance and control tools around the detection location until confidence in removal is restored (Te Korowai o Waiheke, 2023).
- Te Korowai o Waiheke (2023) maintained a dedicated detect-and-response capability for stoats alongside the permanent trap network, deploying alternative trap types, cameras and detection dogs intensively for 2–4 weeks around detections.
- High-confidence public reports provide valuable operational intelligence (Te Korowai o Waiheke, 2023; Predator Free Wellington, 2024).
- Public stoat sightings were ranked by confidence and scaled response intensity accordingly; 50% of high-quality sightings resulted in a stoat being captured within two weeks and within 200 m of the reported location (Te Korowai o Waiheke, 2023).

7.7 Low-density movement

Strength of support: Moderate (approximately 45% of interviews discussing barriers and reinvasion; represented primarily across Researchers and Technical Experts).

Interviewee’s consistently highlighted uncertainty around movement behaviour at low population densities. Researchers repeatedly noted that animals generally move further as densities decline, with dispersing juveniles likely to represent the greatest reinvasion risk, although adults can also make unexpected long-distance movements. One project noted that individual possums can respond differently, with some individuals remaining in a small area and others making long ranging movements. This makes reinvasion difficult to predict and increases uncertainty around appropriate buffer widths and surveillance design. Researchers in particular identified limited understanding of low-density movement, dispersal behaviour and reinvasion dynamics as important constraints on elimination planning. Improving this knowledge was seen as important for designing more effective buffer systems and surveillance programmes.

Research Findings

- Juvenile possums, particularly males, are the primary long-distance dispersers responsible for reinvasion. The proportion of dispersers declines rapidly with increasing distance (Cowan 2000).
- Early studies deduced long-distance dispersal and exploratory movements were uncommon in possums, stating that most possums remain within established home ranges, with only a small proportion undertaking dispersal or exploratory movements (Byrom et al. 2015; Cowan 2000).
- Ship rats readily move hundreds of metres across open pasture, with individuals travelling up to 640 m within a few days. Fragmented agricultural landscapes do not prevent reinvasion and may contain movement corridors, such as fences and waterways, that warrant investigation and potentially targeted management (King et al. 2011).
- Replacement ship rat populations following reinvasion are dominated by juvenile males, consistent with male-biased dispersal, and initially contain fewer breeding females than resident populations (King et al. 2011; Bagasra et al. 2016).
- Reinvading ship rats should be removed as quickly as possible because they initially remain close to the point of entry before dispersing further into the operational area (Speedy et al., 2007).

7.8 Reinvasion pressure

Strength of support: Moderate (approximately 45% of interviews discussing barriers and reinvasion; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Interviewees consistently cautioned against assuming reinvasion occurs at a predictable rate. A small number of interviewees provided specific observations on reinvasion pressure and the speed of reinvasion. One project reported possum detections mostly within 500-1000 m of the project edge, although a small proportion of detections occurred up to 5 km inside elimination areas, demonstrating that occasional long-distance incursions can occur (assuming they were reinvaders). Another described lower-than-expected possum reinvasion, largely associated with juvenile male dispersal. One project found cats rapidly recolonised areas with high rabbit abundance, whereas another reported cat reinvasion to be slower than expected. Several interviewees also emphasised that reinvasion pressure changes as operations progress, with slower forward progress allowing reinvasion pressure to accumulate, reinforcing the importance of maintaining momentum and adapting buffer strategies as project areas expand. One project reported more persistent reinvasion pressure where movement corridors or weak boundaries allowed animals back into cleared areas. These examples suggest reinvasion pressure is highly context specific.

Research Findings

- Reinvasion pressure is often substantially greater than initial invasion pressure because surrounding source populations are already established and reinvaders bypass the transport, introduction, colonisation and naturalisation stages (Banks et al. 2018).

- Reinvasion increases with source population size, decreases with increasing distance from the source population, and increases with larger destination areas. Increasing the proportion of dispersing juveniles in source populations also increases reinvasion pressure (Cowan 2000).
- There is little evidence for a “vacuum effect” following possum control. Initial reinvaders are predominantly young animals, particularly males, arriving through juvenile dispersal rather than resident adults shifting home ranges into controlled areas (Cowan 2000).
- Increasing initial knockdown of possums substantially delays population recovery. In the absence of immigration, model predictions indicated that reducing the initial kill from 90% to 70% shortened the time required to recover to half the original density from approximately eight years to approximately three years (Cowan 2000).
- Reinvasion of possums is expected to become significant about one year after surrounding control ceases, but immigration can be substantially mitigated by maintaining an internal control network of approximately one trap per 18-25 ha (Lustig & Wilson 2020).
- Maintaining trap density throughout the managed area is more effective at limiting reinvasion than relying on peripheral buffer zones or simulated dispersal barriers. Trap density within the managed area has a much greater influence on reinvasion than barrier effectiveness, and homogeneous trapping was predicted to outperform concentrating effort in buffer zones for possums (Lustig & Wilson 2020)
- Ship rats rapidly reinvade mainland forest fragments. Reinvaders were detected during eradication, all fragments were reinvaded within one month regardless of isolation, and continual immigration prevented eradication from being maintained (King et al. 2011).
- Reinvasion pressure can vary markedly with source population dynamics. Following a ship rat irruption, dispersal increased approximately five-fold, and rats dispersed across water gaps of at least 80 m between islands (Bagasra et al. 2016).
- Stoats were eradicated from two of three Fiordland islands within four months using trap densities of one trap per 3.6-11 ha, and permanent trapping at approximately one trap per 11 ha was considered sufficient to prevent establishment where reinvasion rates remained low (Elliott et al. 2010).

7.9 Additional Comments

- Use low-quality habitat as passive buffer zones where possible.
- Pulse suppression in buffers during peak dispersal periods rather than maintaining constant effort.
- Use dye markers in buffer bait to identify whether animals entering the core have interacted with buffer devices.
- Trial modified rabbit fences as low-cost structures to slow reinvasion and increase detection opportunities.
- Establish dedicated reinvasion or biosecurity ranger roles.
- Use community volunteers to manage buffer networks while specialist teams focus on elimination areas.
- Consider whether clearly defined buffers improve long-term community support compared with intermittent surveillance.

8 Biodiversity and outcomes monitoring

8.1 Core message

Interviewees consistently emphasised that biodiversity outcomes should define the purpose of predator management, rather than elimination becoming the objective itself. However, views diverged on the role biodiversity monitoring should play within elimination programmes, particularly where resources are limited or the primary goal is to advance elimination or eradication knowledge. The strongest argument for biodiversity monitoring within elimination programmes was as a metric of progress that is valuable for stakeholder support and ongoing social license.

8.2 Biodiversity outcomes should define programme objectives

Strength of support: Very strong (approximately 75% of interviews discussing biodiversity and outcomes monitoring; represented across Researchers, Predator Free Advisors, Technical Experts, Project Managers and Strategic Experts).

Interviewees consistently recommended defining the desired biodiversity outcomes before deciding which pests to target or whether elimination is the most appropriate management approach. Several argued that elimination should not become the objective in itself but instead be considered one pathway towards biodiversity restoration. Multiple interviewees also emphasised involving iwi, communities, landholders and stakeholders early to determine which outcomes are most valued, recognising that social aspirations are an important component of programme design.

Several interviewees also questioned whether elimination should be pursued if it provides little additional biodiversity benefit over effective suppression. Researchers repeatedly highlighted a major knowledge gap around the cost-effectiveness of removing the final individuals and whether the additional effort produces meaningful biodiversity gains. Several recommended comparing biodiversity outcomes achieved per dollar invested rather than focusing solely on whether elimination has been achieved. One expert questioned whether projects should move away from suppression versus elimination terminology altogether and instead compare management approaches according to biodiversity outcomes per hectare and cost. One interviewee suggested that if whole-ecosystem restoration is the objective, fenced sanctuaries provide an established model and proposed the Kaitake Range as a potential biodiversity core for Taranaki.

Research Findings

- Deeply endemic species respond more strongly to pest control than recent native or introduced species and should be prioritised when setting restoration objectives (Binny et al. 2021).
- Restoration programmes should match the pest management regime to the conservation objective, using eradication-focused management for the most vulnerable species and suppression-focused management over larger areas for less vulnerable species (Binny et al. 2021).
- Conservation decisions should integrate ecological effectiveness with financial, ethical and social considerations when selecting between pest control, habitat restoration and other management options (Ruffell & Didham 2016).

- Schedule predator control to coincide with periods of greatest conservation benefit. For protecting breeding birds, late winter to early spring control provides the greatest protection during nesting and fledging (Predator Free New Zealand Trust 2021).
- Biodiversity benefits generally increase as pest abundance approaches zero. Predicted suppression thresholds can guide management, with post-control rat tracking indices recommended not to exceed approximately 15%, and bird responses improving as rat indices approach zero (Binny et al. 2021).
- Long-term biodiversity monitoring is essential for restoration programmes. Monitoring should assess progress towards predefined restoration endpoints, compare restoration trajectories under different pest management regimes, guide decisions about when management should be maintained, intensified or reduced, demonstrate biodiversity outcomes to stakeholders, and inform future management and policy (Binny et al. 2021).
- Biodiversity monitoring should evaluate restoration trajectories across multiple taxa rather than relying on individual species, allowing managers to assess whether conservation objectives are being achieved and to prioritise future investment (Binny et al. 2021).

8.3 Biodiversity monitoring versus elimination science

Strength of support: Moderate (approximately 45% of interviews discussing biodiversity and outcomes monitoring; represented across Researchers, Technical Experts, Project Managers and Operational Staff).

Interviewees differed on how much biodiversity monitoring should accompany elimination programmes. Several operational interviewees considered biodiversity monitoring a potential diversion of resources from elimination where budgets were limited. One project was using annual five-minute bird counts while focusing most resources on eradication operations, with more comprehensive biodiversity work undertaken separately by a trust. In contrast, several researchers argued that biodiversity outcomes ultimately justify elimination programmes and therefore should remain central. Others distinguished between programmes intended to restore biodiversity and those designed primarily to develop eradication methods, arguing that if the objective is eradication research, resources should explicitly prioritise learning over biodiversity monitoring.

Interviewees differed on the level of biodiversity monitoring that should accompany elimination programmes. Several operational interviewees considered biodiversity monitoring a diversion of resources where budgets were limited, arguing that effort should remain focused on achieving elimination. Other projects made limited effort to capture biodiversity gains and relied on external or other groups. One project, for example, conducted annual five-minute bird counts while directing most resources towards pest control operations, with more comprehensive biodiversity monitoring undertaken separately by the project Trust.

In contrast, several researchers argued that biodiversity monitoring is essential for demonstrating the outcomes and value of elimination programmes. Others suggested that the appropriate level of monitoring should reflect the programme’s primary purpose. Where the objective is to restore biodiversity, comprehensive outcome monitoring was considered important. Where the primary objective is to develop and refine elimination methods, interviewees argued that monitoring effort should prioritise evaluating operational performance and generating evidence to improve future elimination programmes.

8.4 Biodiversity benefits

Strength of support: Moderate (approximately 45% of interviews discussing biodiversity and outcomes monitoring; represented across Project Managers and Operational Staff).

Several operational interviewees described biodiversity outcomes as becoming increasingly important as pest detections decline and operational progress becomes less visible. One operational interviewee noted that maintaining momentum is relatively straightforward while many pests are being caught, but that biodiversity monitoring becomes increasingly important once catches become rare. Rather than motivating teams and demonstrating success through trap catches alone, projects used evidence of biodiversity recovery to reinforce why elimination work continues and to maintain support from communities, funders and staff. One project also reported economic and social outcomes alongside biodiversity outcomes to demonstrate the broader value of the programme. Several interviewees also stressed the importance of establishing biodiversity monitoring early so that ecological change can be measured and demonstrated over time.

Examples included:

- One project established five-minute bird counts early using experienced observes so meaningful before-and-after comparisons could be made.
- One project selected indicator species that reflected the target pest (e.g. kiwi and kākā for stoat control).
- Another project reported 16 years of kiwi call counts and had recently added five-minute bird counts across approximately 300 ha.

Research Findings

- In a 6,000 ha pastoral landscape, predator control resulted in rapid increases in native skink site use and higher cockroach abundance, while cave wētā, tree wētā, spiders and slaters showed no detectable response (Glen et al. 2018).

8.5 Evaluate outcomes

Strength of support: Moderate (approximately 40% of interviews discussing biodiversity monitoring and outcomes; represented primarily across Researchers).

Several researchers argued that elimination programmes often fail to document why operational outcomes occur, limiting opportunities to improve future programmes. One interviewee questioned whether adaptive management is truly occurring if methods are changed without recording the reasons for success or failure. Others suggested monitoring should evaluate the effectiveness of operational decisions, enabling programmes to identify which management actions contributed to success rather than simply whether objectives were achieved.

Research Findings

- Applying predator removal to untreated comparison areas later in a study (treatment extension) strengthens inference that observed biodiversity responses are attributable to predator control (Glen et al. 2018).
- Occupancy modelling provides a robust method for linking changes in native fauna to changes in predator populations and is preferable to relying solely on simple detection rates (Glen et al. 2018).
- Reliable biodiversity indicators and long-term monitoring programmes are needed to assess environmental trends in production landscapes. Birds are suitable indicators, but improved monitoring, greater understanding of farmland bird ecology, and evaluation of conservation covenants and habitat restoration projects are required (MacLeod et al. 2008).

8.6 Additional Comments

- Systematically record and report operational outcomes and lessons learned to support adaptive management and improve future programmes.
- Select biodiversity indicators that are directly linked to the expected impacts of the target pest species.
- Consider animal welfare and ethical obligations by ensuring pest control is guided by clearly defined biodiversity outcomes.

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9 Community and social license

9.1 Core message

Interviewees consistently identified social license as one of the largest challenges facing mainland elimination. The strongest recurring messages were to begin engagement early, secure and maintain access to private land, involve communities and iwi in decision-making, and recognise that social license requires continual investment throughout the life of a programme. Interviewees viewed social license as more than public acceptance, it influenced access, tool selection, operational feasibility and the long-term sustainability of elimination programmes.

Interviewees differed on the long-term role communities should play once elimination is achieved. Some viewed volunteers and landholders as the logical long-term biosecurity workforce, whereas others considered core surveillance and response should remain professionally managed. There was also uncertainty around the effectiveness of backyard trapping at landscape scale, the level of landholder participation required to achieve elimination, and whether some control methods will ever achieve sufficient social license for widespread mainland application.

9.2 Establish social license early

Strength of support: Very strong (approximately 80% of interviews discussing community and social license; represented across Researchers, Technical Experts, Project Managers, Operational Staff, Community Engagement and Strategic Experts).

Interviewees consistently recommended beginning social license work well before field operations. Several described it as the longest component of project establishment and a prerequisite for feasibility and eventual scaling. Multiple interviewees recommended discussing proposed methods, particularly toxin use, from the outset rather than avoiding difficult conversations. Several also advocated undertaking small operational trials early because they help demonstrate methods, build trust and provide tangible examples that are easier for communities to understand than theoretical proposals.

Research Findings

- Social feasibility should be considered an integral component of technical feasibility rather than a separate communications activity (Lord Howe Island Board, 2025).
- Develop social impact and community engagement plans before deciding whether to proceed with eradication (Lord Howe Island Board, 2025).
- Community engagement staff should be embedded within the community well before implementation or recruited locally wherever possible (Lord Howe Island Board, 2025).
- Cultural license should be established early through free, prior and informed consent before collecting or using information from Indigenous lands. Cultural authority agreements provide a practical mechanism for establishing agreed engagement processes. (Wood et al. 2024).
- Early engagement with mana whenua should include a disclosure document describing the purpose and methods of surveillance (Wood et al. 2024).

9.3 Community shapes programme design

Strength of support: Strong (approximately 65% of interviews discussing community and social license; represented across Predator Free Advisors, Project Managers, Operational Staff and iwi representatives).

Interviewees repeatedly recommended involving communities, landholders, iwi and hapū in programme planning rather than consulting only after decisions have been made. Specific recommendations included; sharing proposed methods early enough for meaningful discussion and input, identifying what different stakeholder groups value before developing operational plans, and making sure to engage with the correct iwi first, while recognising that in some areas hapū lead operational decisions.

One interviewee also described the importance of understanding treaty settlement structures, recognising Post Settlement Governance Entities, and identifying the appropriate operational and governance contacts for each rohe before engagement begins. Sharing information, incorporating tikanga and working through existing relationships were viewed as essential for developing long-term support.

Research Findings

- Community members should participate in determining both the eradication goal and the implementation approach to strengthen ownership and long-term support (Lord Howe Island Board, 2025).
- Mana whenua should be directly involved in designing surveillance, selecting priorities, interpreting observations and implementing surveillance programmes (Wood et al. 2024).
- Māori knowledge and empirical scientific knowledge should be treated as complementary knowledge systems, with neither requiring validation by the other before informing surveillance and management (Wood et al. 2024).
- Conduct comprehensive and empathetic consultation using trained facilitators, eradication expertise and local knowledge. Consultation outcomes should directly inform feasibility assessments, operational planning and project management (Lord Howe Island Board, 2025).
- Face-to-face engagement provides opportunities to identify suitable device locations, gather local knowledge on target species, recognise property-specific constraints and tailor discussions to individual landowners (Predator Free Wellington, 2024).
- Participatory programme design can be used to investigate potential unintended ecological consequences and collaboratively develop mitigation strategies with landholders (Niemiec et al. 2017).
- In urban environments, understand local attitudes towards eradication methods before implementation and use surveys and small-scale trials to test community acceptance of proposed approaches (Predator Free Wellington, 2024).

9.4 Access dictates success

Strength of support: Strong (approximately 60% of interviews discussing community and social license; represented across Researchers, Technical Experts, Project Managers, Operational Staff and Community Engagement).

Many interviewees identified access to private land as one of the greatest barriers to mainland elimination, particularly for rats, where missing a single property could allow populations to persist or recover. Maintaining access over many years was considered more challenging than obtaining initial permission, particularly where regular visits are required. Several interviewees recommended prioritising access agreements early and developing property-specific management plans that accommodate farming operations and individual landholder preferences.

Operational examples included:

- One project suggested allocating 20% of programme budget to obtaining permissions and community engagement.
- The same project employed a 0.75 FTE social engagement officer dedicated to permissions and communication.
- One project planned to contract a local person specifically to manage landholder relationships.
- Several interviewees highlighted seasonal farming activities (e.g. calving) as practical constraints that need to be incorporated into operational schedules.
- One project found areas where access could not be obtained became persistent rat source areas.
- One project reported transitioning from bait stations to H2zero toxic bait dispensers for rats across private rural property, which reduced the need for frequent property access and eased tensions with landholders.

Research Findings

- Failure of one landholder to control pests can reduce the effectiveness of neighbouring control through reinvasion (Glen et al. 2016; Niemiec et al. 2017).
- Non-participation by owners of small properties has little effect on predator control effectiveness, whereas non-participation by owners of large properties substantially reduces programme effectiveness through reinvasion. Reallocating traps from non-participating large properties to neighbouring properties can largely offset these effects (Glen et al. 2016).
- Landholder participation is influenced by the perceived value of pest reduction, the perceived cost and difficulty of participation, confidence in their ability to contribute effectively, expectations that the programme will succeed, and expectations that others will also participate (Glen et al. 2016; Niemiec et al. 2017).
- Landowners also consider whether the benefits and responsibilities of pest management are shared fairly and may develop views based on local ecological concerns, including the potential for unintended increases in other pest species (Niemiec et al. 2017).
- Agencies should address landholders' beliefs about the local social and ecological context rather than relying solely on subsidies or information about pest impacts or control methods (Niemiec et al. 2017).

- Property access should be planned as a technical component of eradication because incomplete operational coverage creates a direct risk of eradication failure (Lord Howe Island Board, 2025).
- Property access requires property-specific planning rather than a standardised approach because access conditions vary substantially between landowners (Lord Howe Island Board, 2025).
- Build flexibility into operational planning to accommodate different landowner requirements while maintaining complete operational coverage (Lord Howe Island Board, 2025).

9.5 Communication is critical

Strength of support: Strong (approximately 55% of interviews discussing community and social license; represented across Project Managers, Operational Staff, Community Engagement and Strategic Experts).

Many interviewees considered communication to be a specialised component of programme delivery rather than a supporting activity. Repeated themes included openly discussing toxin use, responding directly to community concerns, tailoring messages to different audiences and communicating biodiversity outcomes to maintain support. Several projects described dedicated communication staff or targeted communication strategies as essential components of successful delivery. Projects emphasised continued communication and regular feedback to demonstrate that work is still delivering benefits.

Operational examples included:

- Using annual kererū and kākā counts to demonstrate ecological recovery.
- Using different communication strategies for different suburbs or demographic groups.
- Using targeted communications developed from community feedback rather than generic messaging.
- Maintaining regular engagement with landowners after permissions have been obtained.

Research Outcomes

- Outreach should communicate why control strategies are expected to succeed, how many people are expected to participate, how much participation is required for success, and the expected biodiversity outcomes of collective action (Niemiec et al. 2017).
- Regularly communicating monitoring results, programme progress and achievement of intermediate goals can strengthen continued participation, reinforce positive social norms, and encourage social accountability (Glen et al. 2016; Niemiec et al. 2017).
- Long-term monitoring should measure both predator removal and biodiversity outcomes because communicating these outcomes may improve landholder attitudes towards participation (Glen et al. 2016).
- Surveillance data should be centralised, standardised, transparent and shared across organisations (Wood et al. 2024).
- Surveillance data collected from Indigenous lands should recognise Indigenous data sovereignty by ensuring information remains linked to its place of origin and that mana whenua retain rights over access, use and governance (Wood et al. 2024).

- Maintain regular communication before and throughout implementation using consistent, accessible information to minimise misinformation and maintain community confidence (Lord Howe Island Board, 2025).
- Community champions should receive regular project updates so they can communicate accurate information through trusted local networks (Lord Howe Island Board, 2025).

9.6 Volunteers increase capacity but require investment

Strength of support: Moderate (approximately 50% of interviews discussing community and social license; represented across Operational Staff, Project Managers and Technical Experts).

Interviewees generally supported volunteer involvement but emphasised that volunteers should complement, rather than replace, professional operations. Volunteers, landholders, and local communities were viewed as valuable contributors to surveillance, device servicing, biodiversity monitoring, and long-term biosecurity. Several interviewees emphasised the importance of training, quality assurance, and integrating volunteers into operational teams to maintain data quality and long-term engagement. Several interviewees considered eradication itself too dependent on consistency to rely on volunteers.

Operational lessons included:

- One project recommended obtaining property access for paid operational staff rather than relying on landholders to undertake control themselves.
- One operational programme successfully used volunteers to service established traplines after experienced staff completed the initial design and installation.
- One project audited volunteer traplines annually using experienced staff.
- One project required volunteers to complete formal training and competency testing before operating independently.
- Another project built knowledge transfer into programme design from the outset through workshops, assigning volunteers responsibility for specific traplines once trained.
- One operational interviewee reflected that landowners should have been involved in servicing devices much earlier in the programme because many were willing to contribute.

Research Findings

- Social norms are important predictors of participation. Recruiting influential community members early can help establish participation as the social norm and improve confidence that collective action will succeed (Glen et al. 2016).
- Continued high levels of landholder participation are required to maintain gains achieved through the initial broad-scale knockdown of predators (Glen et al. 2016).
- Continued monitoring and oversight of participation are important to prevent loss of motivation caused by perceptions that others are not contributing ("sucker effect") (Niemiec et al. 2017).
- Building capability within mana whenua provides a sustainable workforce for long-term surveillance and monitoring beyond short-term funding cycles (Wood et al. 2024).

9.7 Social license influences operations

Strength of support: Moderate (approximately 45% of interviews discussing community and social license; represented across Technical Experts, Strategic Experts and Operational Staff).

Interviewees described social license as directly influencing which tools can be used, where they can be deployed and therefore the cost and feasibility of elimination. Several interviewees argued that developing socially acceptable technologies is as important as improving technical performance.

Examples included:

- One technical expert described extensive work with industry organisations and dairy companies before H2Zero devices were accepted by farmers.
- One operational programme focused on removing feral cats first to build public confidence before introducing more contentious rat control methods.
- Another project removed stoats before rats for the same reason.
- Cage traps are used as the predominant method of cat elimination by one project because accidentally dispatching a pet cat would severely damage social license.

Research Findings

- Successful environmental management depends on societal cooperation and commitment as well as ecological effectiveness (Glen et al. 2016).
- Failure to adequately understand community expectations and concerns early in project development can result in technical compromises, operational delays, increased costs and damage to long-term community relationships (Lord Howe Island Board, 2025).
- Where adequate community support cannot be achieved following comprehensive consultation, programmes should carefully consider whether implementation should proceed (Lord Howe Island Board, 2025).
- Predator control is most effective when neighbouring landowners coordinate and synchronise operations, reducing reinvasion and increasing landscape-scale effectiveness (Predator Free New Zealand Trust 2021; Kiwi Coast 2020).

9.8 Additional Comments

- Allocate approximately 20% of programme budgets to permissions and engagement.
- Use smaller demonstration trials to build understanding and social acceptance before scaling up.
- Develop species-specific technologies that improve public acceptance.
- Use locals where possible to undertake property access and relationship management.
- Challenge the public to prove the project wrong by reporting any remaining animals as a surveillance tool.
- Use community sightings as an intentional surveillance network during mop-up.
- Use security cameras already owned by landholders as an additional surveillance source.
- Empower communities rather than simply consulting them.

10 Knowledge gaps

Interview participants consistently identified important knowledge gaps that limit operational confidence. Although these uncertainties do not prevent implementation, they influence programme design, operational efficiency and long-term success. The priorities presented in Table 1 represent the knowledge gaps most frequently identified during interviews and highlight areas where additional research, operational experience and targeted trials would strengthen mainland elimination programmes. Many of these uncertainties could be addressed through adaptive management embedded within programme delivery, with collaboration between operational programmes and research organisations forming an integral component of this process.

Knowledge gaps are presented in order of the number of interview statements assigned to each topic, providing an indication of their relative prominence across interviews. Not all interviewees identified knowledge gaps, and some identified multiple priorities. The number of mentions should therefore be interpreted as an indication of the relative prominence of each topic rather than the proportion of interviewees identifying it. Interview statements have been edited only where necessary to improve readability while retaining their original meaning. Where species are not specified, they were not identified by the interviewee.

Table 1. Priority knowledge gaps for mainland multi-species predator elimination identified through expert interviews.

Research priority	Knowledge gaps identified by interviewees	Mentions*	Why it matters for TPFT
Low-density movement and behaviour	• Movement of possums at low density (x2) • Movement of individuals at low densities (x2) • Movement of female possums at medium density • How pest movement, behaviour, feeding preferences, home ranges and interactions change at low densities • Location of individuals at low densities • Behaviour of possums at low densities and interaction with devices • Movement of survivors • Behavioural responses of survivors • Lack of detectability and neophobia of survivors.	11	Understanding behaviour as populations approach elimination is fundamental to locating, detecting and removing the final individuals.

Tool development and optimisation	• Testing of novel tools • Differences in susceptibility to traps/placement/tools between rat species • Norbormide effectiveness on different rat species • How to increase interaction rates of cats with devices • Phasing of tools for cats • Scent and sound lures • Species-specific toxins of low/nil environmental concern • Other tools than brodifacoum for large-scale eradication • PAPP use in farmland (to target cats and stoats) • How best to incorporate toxins into operations • Context specific effectivenss of toxin for possums.	11	More effective surveillance and control tools could improve detection probability, operational efficiency and removal of the final individuals while reducing environmental impacts.
Reinvasion & buffer design	• Reinvasion pressure (x3) • Pest reinvasion behaviour - how fast do they spread (e.g. put collars on animals, how long until we detect and remove them (stoats and possums)) • Whether to focus effort on reducing invasion pressure outside the project area or target individuals inside the project area • Reinvader behaviour • Identifying invaders versus remaining individuals • Whether predator elimination increases reinvasion pressure from surrounding populations • The optimal buffer design for different species and landscape types.	9	Understanding reinvasion processes and designing effective buffer systems are fundamental to preventing recolonisation and maintaining predator-free status.
Species-specific ecology and management	• Ship and Norway rat distribution in the landscape - should we be targeting them differently • Detection and distinction of weasels and stoats • How to distinguish between ship and Norway rats with a detection device • Effective targeting of weasels • Anything about weasels • Home ranges of rats • The spatial areas female animals occupy for all species.	7	Species-specific ecological knowledge is needed to optimise surveillance and control methods for each target species.

Detection and surveillance systems	• The relative cost-effectiveness of cameras and scat surveys for surveillance • What is the ideal detection network for rats • Better stoat detection • Detection at scale - how dense does our detection network need to be • Timing and impact of different responses to detections • Can mustelid dogs help us to understand mustelid home range boundaries.	6	Improving surveillance design will increase confidence that predators are detected rapidly and reliably as densities decline.
Mainland elimination strategy	• Best practice for mainland elimination • Best way to achieve elimination • What are the criteria for elimination • What costs are incurred, and what approaches are needed to achieve mainland elimination • Understanding the chains of assumptions around the practical strategies of elimination • How to achieve elmination with no clear natural boundaries.	6	A clearer operational framework for mainland elimination would improve programme design, decision-making and consistency between projects.
Last individuals	• How to remove the last individuals (x2)• How are we going to prove zero and how much effort will it take • How long does it take to remove the last individuals from urban environment • Can we keep it at zero in a cost effective way.	5	Removing the final individuals and demonstrating elimination remain the greatest operational challenges for mainland predator elimination programmes.
Rural implementation	• Effective control of rodents across farmland and particularly dairy landscapes • How do you achieve elimination in the rural/urban confluence • How to work around stock in rural landscape • How to defend a rural landscape • Effective engagement with farmers.	5	Improving operational approaches for rural landscapes is critical because much of mainland predator elimination will occur outside conservation land.

Biodiversity outcomes	• The levels of predator suppression required to achieve measurable biodiversity outcomes (x2)• The cost-effectiveness of elimination compared with long-term suppression for achieving biodiversity outcomes • How bird responses vary across different rat densities	4	Better understanding of biodiversity outcomes would help demonstrate programme benefits and inform investment decisions.
Landscape-scale ecology and restoration	• The spatial scale at which establishing a core area becomes cost-effective • The ecological benefits of halo areas surrounding fenced sanctuaries • Biodiversity outcomes in fragmented landscape • Habitat restoration and impacts.	4	Understanding how landscape configuration influences outcomes would improve programme design and maximise ecological return.
Timing and sequencing	• The optimal timing for conducting and pausing control • Sequential versus staggered effectiveness and cost • Applying all the tools at once versus stages of variation.	3	Optimising the timing and sequencing of operations could improve efficiency and overall programme effectiveness.
Social license	• How to build social license and understand the human dimensions of eradication • Approaches for collaboratively defining programme scope and purpose and identifying the different values held by participants.	2	Long-term programme success depends on maintaining community support and participation.
***Note:** *Research priorities are ordered by the number of knowledge-gap statements raised during expert interviews. Counts indicate the relative prominence of each topic rather than the proportion of interviewees identifying it.*			

11 Multi-species design principles for TPFT

This section brings together the evidence presented in Sections 1-10 into a set of evidence-based design principles for Towards Predator-Free Taranaki (TPFT). The principles synthesise findings from expert interviews, published literature and the key knowledge gaps identified across both evidence sources, providing evidence-informed guidance for programme planning and implementation. They are intended to support informed decision making and should be refined as operational experience is gained and new evidence becomes available.

11.1 Programme Design

11.1.1 Objectives and scope

- Clearly define the programme objective from the outset, including whether the goal is elimination (and what that means in the TPFT context), and ensure that programme design, monitoring and evaluation align with that objective.
- Design the programme around the fundamental requirements for elimination, including exposing all individuals to control, managing reinvasion and demonstrating success.
- Base programme design on Western Taranaki's ecological and operational context rather than adopting generic prescriptions or approaches developed elsewhere.
- Develop an understanding of local predator communities, species distributions, habitat use, reinvasion pathways and operational constraints before finalising surveillance and control strategies.
- Use planning tools, modelling and local knowledge to evaluate alternative programme designs and reduce avoidable redesign during implementation.
- Treat social license as a core component of programme feasibility and design rather than as a separate communications activity.

11.1.2 Feasibility

- Assess feasibility before implementation and continue reassessing it as new information becomes available, rather than treating feasibility as a one-off planning exercise.
- Scale the programme to match TPFT's ability to deliver, defend and sustain operations, recognising that expanding too quickly increases operational risk.

11.1.3 Operational phases

- Recognise knockdown, mop-up and long-term biosecurity as distinct operational phases that require different objectives, surveillance approaches and decision-making.
- Develop practical and adaptable transition criteria between operational phases, recognising that these are likely to require refinement as operational experience accumulates.
- Use staged implementation to build capability, refine methods and demonstrate success before expanding into larger operational areas.

11.1.4 Adaptive management and learning

- Learning should be designed into the programme rather than occurring incidentally, treat operational learning as a programme outcome.
- Operations should be structured to answer important management questions while simultaneously progressing elimination.
- Incorporate structured trials to resolve important uncertainties before large-scale implementation rather than relying on untested assumptions.
- Trials should be designed to answer specific operational questions that directly inform programme design, surveillance, control methods or decision-making.
- New tools and technologies should be validated under Western Taranaki conditions before being relied upon operationally.
- Remain adaptable as evidence from operational trials becomes available, with successful approaches incorporated and ineffective approaches modified or abandoned.

11.1.5 Capability and supporting systems

- Develop operational capability, specialist expertise and supporting systems before implementation.
- Incorporate contingency planning and independent technical review into programme development to reduce avoidable operational failures.
- Design monitoring and surveillance as core programme infrastructure that supports adaptive management throughout implementation.
- Data management should be treated as essential operational infrastructure. GIS, surveillance databases, image-processing capability and integrated monitoring systems need to be established before implementation to support programme delivery.

11.2 Operations

11.2.1 General principles

- Surveillance objectives should be clearly defined before programme design, recognising that knockdown, detect-and-respond, proof of absence and long-term biosecurity each require different surveillance strategies.
- Surveillance and control should be designed around target-species ecology, movement behaviour and probability of detection rather than standardised grids or fixed operational prescriptions.
- Systems should be designed to ensure every individual has an opportunity to encounter a surveillance or control device, with spacing, placement and density determined by the most spatially constrained target species.
- Rely on multiple complementary surveillance and control methods rather than a single tool, recognising that different devices detect and remove different individuals.
- Surveillance design, proof-of-absence modelling and operational planning should be developed together so that surveillance data directly supports programme evaluation and decision-making.

- Recognise that surveillance should increasingly guide where, when and how operational effort is applied as populations decline.
- Surveillance and control networks should remain adaptive throughout the programme, using operational data to refine device placement and servicing as conditions change.

11.2.2 Operational design

- Surveillance network design should be trialed and refined to achieve an appropriate balance between detection performance, operational practicality and cost.
- Device, trap, bait and lure selection should be based on demonstrated field performance for the target species and local conditions rather than assumed effectiveness.
- Multi-species tools and integrated surveillance systems should be used where they improve operational efficiency without compromising species-specific requirements.
- Implement multiple complementary methods rather than relying on a single surveillance tool, recognising that different methods detect different individuals and species.
- Prioritise deploying tools in the optimal location and maintaining them to a consistently high operational standard rather than focusing on specific devices.
- Toxic baiting strategies should maximise bait acceptance while minimising bait aversion through appropriate pre-feeding, complete bait coverage and delivery of lethal doses.
- Bait and lure strategies should be adapted throughout the programme, matching attractants to the target species, operational phase and local conditions while varying lure types to reduce behavioural avoidance and maintain effectiveness.
- Reserve alternative tools and technologies for later operational phases to reduce behavioural avoidance and improve removal of the final individuals.
- Develop scalable detection-response protocols that allow surveillance and control effort to be rapidly intensified around confirmed detections.
- Operational design should incorporate observations from field staff and independent technical review to continually refine programme delivery.

11.2.3 Species specific design

General multi-species principles

- Programme design should explicitly consider interactions among target and non-target species, anticipating whole-community responses rather than planning surveillance and control for each species independently.
- Assumptions about trophic interactions should be validated within the Western Taranaki landscape rather than assuming responses reported elsewhere will occur under local conditions.
- Use species interactions deliberately where they provide operational advantages, including increasing detectability, improving bait uptake and exploiting secondary poisoning pathways.
- Seek efficiencies by integrating surveillance, infrastructure, logistics, staffing and field operations across multiple species wherever practical, even where species are ultimately removed sequentially.
- Species with the most demanding surveillance or control requirements should determine the design specifications for integrated multi-species operations where appropriate.

- Incorporate species-specific approaches into the final stages of elimination.

Species sequencing

- The sequence of species elimination should be determined by programme objectives, local ecology, operational feasibility and social license rather than applying a predetermined order of control.
- Alternative sequencing scenarios should be evaluated during programme planning before committing to an operational approach.
- Simultaneous removal of multiple target species should be the preferred approach where operationally feasible.
- Programme scope should remain flexible where feasibility assessments indicate that simultaneous elimination of all target species is unlikely to succeed, allowing effort to focus initially on species that are currently achievable.

Rats

- The distribution and identity of rat species should be confirmed before operations commence.
- Rat surveillance and control should be designed specifically for the target species (ship rat, Norway rat and/or kiore), recognising differences in habitat use, movement behaviour, home ranges, lure preferences, trap requirements and responses to certain toxins.
- Device spacing should be determined by the smallest home range of the target species, local habitat quality and the objective of the programme, rather than standard spacing guidelines.
- Approximately 25 × 25 m spacing represents best practice where complete rat elimination is the objective or uncertainty exists, while wider spacing (e.g. 50 × 50 m) may be appropriate in some habitats or programme phases where evidence supports it.
- Rat surveillance should integrate multiple complementary detection methods.
- Cameras should form a core component of low-density rat surveillance.
- Rodent detection dogs should be considered as part of low-density surveillance.
- Devices should be positioned where rats are most likely to travel or forage rather than relying solely on uniform grids, with habitat features such as compost bins, vegetation edges, buildings, waterways and other high-use areas receiving additional attention.
- Rat bait stations should be installed before toxic baiting where possible to reduce neophobia and maximise bait uptake.
- Bait acceptance should be confirmed during programme planning, especially in areas where abundant alternative food sources could reduce bait uptake.
- Alternative food sources within the operational area should be minimised where practical to maximise bait uptake and reduce reinvasion risk.
- Baiting operations should ensure complete and continuous bait availability across the entire treatment area, with particular attention given to locations where bait coverage gaps are likely to occur.
- Rat elimination should progress from broad-scale toxin knockdown to increasingly targeted trapping and surveillance during mop-up.
- Species-specific approaches should become increasingly important as operations progress towards elimination.

- Surveillance systems should become progressively more targeted as rat density declines, modifying spacing and intensity in response to operational information.
- Bait type, lure type and control methods should be varied throughout operations.
- Trap placement, stability and presentation should minimise the risk of educating surviving rats through unsuccessful encounters or escapes.
- Where newly established rat populations can be eliminated effectively before they spread, surveillance should prioritise detecting those populations rather than individual invaders, as this may provide a more detectable and operationally efficient target.
- Demonstrating rat eradication should rely on dedicated post-operational surveillance rather than the absence of detections.
- Genetic samples should be collected before eradication to distinguish survivors from reinvaders (if possible in the TPFT landscape) and identify invasion pathways.

Possums

- Possum distribution should be assessed before operations where it will improve surveillance design and tool deployment.
- Surveillance and control spacing should be based on the smallest expected possum home ranges rather than average movement distances.
- Possum surveillance should integrate complementary detection methods rather than relying on a single surveillance tool.
- Cameras should complement, rather than replace, other surveillance methods for low-density possums. Camera spacing of approximately one camera per 25 ha should be considered where high detection confidence is required.
- Wax tags and chew cards should be used strategically, recognising that deployment timing and recent toxin operations can substantially influence detection sensitivity.
- Trap placement is more important than trap type and should be guided by possum movement and surveillance information.
- Long-lasting lures should be considered where they improve possum detection and reduce non-target interference.
- Possum control should progress through planned operational phases, with different surveillance and control methods introduced as populations decline.
- Surveillance should become increasingly targeted and intelligence-led as possum density declines.
- Detection dogs should become an increasingly important component of surveillance and targeted control during mop-up.
- Dual-bait strategies should be considered during mop-up, with substantially different bait formulations used sequentially to overcome bait aversion in surviving possums.
- Highly attractive focal sites (“possum nightclubs”) should be considered during mop-up by repeatedly pre-feeding surviving possums to known locations before simultaneously activating 4–6 traps to maximise capture success.
- Elimination areas and buffer areas should be managed using different surveillance and response strategies.

Mustelids

- Mustelid management should distinguish between stoats, ferrets and weasels, recognising that each species requires different surveillance, trap designs, spacing and control strategies.
- Weasel control should not rely on stoat or ferret trap networks. Weasels require lighter trigger weights and substantially denser trap spacing because of their smaller size and home ranges.
- Trap and surveillance spacing should be based on the smallest home ranges within the target population, particularly female stoats, to ensure every individual has an opportunity to encounter a device.
- Stoat traplines should generally be no more than 400–500 m apart where eradication is the objective, with traps commonly spaced 100–200 m apart along traplines. Wider spacing may leave some females unexposed to control devices.
- Trap density should ensure a high probability of encounter rather than simply increasing trap numbers, recognising that increasing density beyond this point provides diminishing returns.
- Mustelid trap networks should be designed around movement corridors and high-use habitat rather than uniform grids, concentrating effort along waterways, coastlines, ridgelines, tracks, roads, bridges, culverts and other predictable travel routes.
- Permanent mustelid trap networks should be maintained wherever practical, recognising that every remaining animal requires an opportunity to encounter a trap even when captures become infrequent.
- Mustelid surveillance should combine complementary methods, with cameras, detection dogs and other tools selected according to local performance.
- Experienced field staff and detection dogs should be used to guide device placement.
- Trap placement, presentation, servicing frequency and trap density around high-use areas should be continually refined using surveillance and capture data while maintaining overall landscape coverage.
- Trap presentation should be treated as an important operational variable. Tunnel design, trap orientation, entry size, accessibility and trap presentation should be refined where interaction or capture rates are low.
- Stoat traps should be pre-baited before activation and lure strategies should remain adaptive throughout the programme, with lure type, freshness and servicing frequency adjusted to season, prey availability and operational performance.
- Fresh meat lures, particularly rabbit, should be the preferred lure for stoats and ferrets, with alternative lure types rotated where operational performance declines.
- Non-target interference should be minimised through trap design, tunnel configuration and trigger settings, recognising that non-target species can substantially reduce trapping efficiency.
- Secondary poisoning and PAPP should be incorporated where appropriate as complementary tools but should not replace dedicated mustelid surveillance and trapping.
- Mustelid control should be maintained continuously, or at least annually, over large areas because of rapid reinvasion potential, high reproductive capacity and long-distance juvenile dispersal.

Cats

- Cat eradication should progress from rapid population knockdown to increasingly targeted removal of the remaining individuals using increasingly specialised methods.

- Cat operations should minimise disturbance, recognising that repeated human activity, failed capture attempts and inappropriate method sequencing can educate cats, alter movement patterns and substantially increase the difficulty of removing survivors.
- Operational responses should not be triggered by single cat detections. Where possible, repeated detections should be used to establish movement patterns before targeted trapping begins, unless immediate intervention is required.
- Use cameras as the primary surveillance method, supported by detection dogs and community reports.
- Camera placement should be focused on ridgelines, fence lines, tracks and habitat edges rather than uniform grids, with spacing determined by local movement patterns and home-range size where possible.
- Operational experience suggests trap spacing of approximately 200–300 m along travel routes is effective in many situations but should be refined using local surveillance data.
- Cage traps should generally form the primary control method, with kill traps, leg-holds and other specialised methods introduced selectively for difficult individuals or where surveillance indicates primary methods are no longer effective.
- Cage traps should be installed well before activation and left permanently in place wherever practical, allowing cats to become accustomed to them.
- Trap performance should be maintained to a very high standard because trap failures and escapes can create long-term trap avoidance that substantially increases the difficulty of removing remaining cats.
- Rotate lure types throughout operations to reflect local prey availability, season and the behavioural responses of remaining cats. Long-life lures may provide particular advantages during the final stages of elimination.
- Control programmes should account for seasonal changes in cat behaviour and breeding biology when planning the timing and intensity of trapping effort.
- Secondary poisoning should be incorporated into programme design where opportunities exist but should be treated as a supplementary benefit rather than a primary cat eradication method.
- At least one effective surveillance or control method should be reserved for the final stages of elimination, rather than deploying every available tool during the initial knockdown.
- Surveillance should continue after apparent elimination, recognising that surviving or reinvading cats may remain undetected for prolonged periods.
- Operational planning and community engagement should explicitly distinguish feral cats from companion cats.

11.3 Demonstrating Success

11.3.1 Last individuals

- Prepare for the final individuals requiring disproportionately greater time, effort and resources than earlier stages of elimination.

- Surveillance design should account for the smallest home ranges and least detectable individuals to maximise the likelihood that every remaining animal has an opportunity to encounter detection devices.
- Surveillance systems should be designed to detect remaining animals rapidly enough that they can be removed before breeding or population recovery occurs.
- Employ multiple complementary surveillance and control methods rather than a single tool, with devices adapted and combined as conditions change.
- Detection and control methods should target the full range of behavioural types within the remaining population rather than assuming all individuals will respond similarly.
- Baits, lures, devices and deployment strategies should be varied and adapted throughout mop-up to maintain effectiveness and improve the likelihood of detecting or removing behaviourally different individuals.
- Surveillance should become increasingly intelligence-led, directing effort towards likely animal locations, historical activity, habitat hotspots and reinvasion pathways rather than maintaining uniform surveillance coverage.
- Surveillance information should be used to continually guide operational decisions, including trap placement, servicing priorities and response effort.
- Evaluate new surveillance tools, behavioural lures and detection technologies according to their ability to improve the efficiency and effectiveness of detecting and removing the final individuals.

11.3.2 Proof of absence

- Proof of absence should be planned from the beginning of the programme rather than considered after elimination has been attempted.
- Programme objectives should clearly define what constitutes proof of absence, including the surveillance effort, confidence threshold and decision criteria required before changing operational phases or declaring elimination.
- Proof of absence should be treated as building confidence under uncertainty rather than proving zero animals remain. Confidence should be built by integrating multiple complementary sources of evidence rather than relying on individual surveillance tools, model outputs or periods without detections.
- Proof-of-absence should be supported by ongoing surveillance and rapid response capability, recognising that statistical confidence does not guarantee eradication.
- Decisions to declare elimination should reflect both the confidence provided by surveillance and the consequences of making an incorrect decision.
- Prioritise surveillance where it will reduce uncertainty to increase confidence, focusing effort on areas with the highest likelihood of undetected animals.
- Proof-of-absence frameworks should explicitly account for reinvasion and, where possible, distinguish surviving animals from new incursions.
- Proof of absence and long-term biosecurity should be viewed as a continuous process rather than a single endpoint.

11.3.3 Long-term biosecurity

- Reinvasion management should be planned as a core component of programme design rather than after elimination has been achieved.
- Programme success should be measured by the ability to detect and remove reinvaders as well as eliminate resident populations, recognising that some reinvasion is inevitable in mainland systems.
- Account for uncertainty in the movement and dispersal of low-density populations when designing buffers and surveillance systems.
- Buffer systems should be designed to minimise reinvasion pressure rather than prevent every incursion and should operate alongside surveillance and rapid response systems.
- Buffer design should be tailored to local species ecology, movement behaviour, landscape features, operational capacity and reinvasion pathways rather than applying standard buffer widths or layouts.
- Buffer and surveillance design should be based on the species that is most difficult to intercept rather than the easiest.
- Natural barriers, low-quality habitat and landscape features that influence animal movement should be incorporated into reinvasion management wherever they reduce reinvasion risk or improve surveillance efficiency.
- Likely reinvasion pathways should be identified and monitored through permanent surveillance, with detections triggering rapid, targeted response before reinvaders become established.
- Reinvasion management should remain adaptive, with buffer design, surveillance and control continually refined as understanding of reinvasion pathways and animal behaviour improves.
- Programme design should distinguish, where practical, between surviving animals and reinvaders to improve interpretation of programme performance and guide refinements to mop-up, surveillance and biosecurity systems.
- Where practical, incorporate genetic techniques and other methods that identify the origin of detected animals to improve understanding of reinvasion pathways, source populations and programme performance.

11.3.4 Biodiversity outcomes

- Programmme design should explicitly determine the balance between investment in biodiversity monitoring, operational delivery and elimination science, recognising that priorities may differ depending on programme objectives.
- Decisions about eliminating the final individuals should consider the additional biodiversity benefit achieved relative to the additional investment required above intense suppression.
- Biodiversity monitoring should be designed from the outset to demonstrate ecological outcomes, evaluate progress towards restoration objectives and maintain support from funders, partners and the wider community.
- Biodiversity indicators should be selected to reflect the conservation objectives and target species of the programme.

11.4 Governance and Delivery

11.4.1 Social license

- Social license should be established before operational delivery begins and treated as a prerequisite for programme feasibility.
- Social feasibility should be considered alongside technical feasibility when determining whether, and how, elimination should proceed.
- Social license should be maintained throughout the life of the programme through ongoing engagement, communication and demonstrated outcomes.
- Communication should be treated as a core operational function throughout implementation that supports participation, maintains trust and addresses concerns.
- Communication should be tailored to different stakeholder groups.
- Biodiversity outcomes should be communicated throughout implementation to maintain support as operational progress becomes less visible.

11.4.2 Partnerships, iwi and landholders

- Communities, iwi, hapū and landholders should be involved in shaping programme objectives and operational approaches from the outset, rather than being consulted after key decisions have been made.
- Programme design should reflect local social, cultural and governance contexts.
- Engage with iwi and hapū early, recognising mātauranga Māori and scientific knowledge as complementary, and incorporating appropriate governance, tikanga and data sovereignty into programme design.
- Recognise long-term access to private land as a critical operational requirement and allocate sufficient resources to secure and maintain landholder participation.
- Accommodate property-specific requirements while maintaining complete operational coverage, landscape-scale coordination and programme effectiveness.
- Incorporate community participation into long-term surveillance and biosecurity, recognising that sustained mainland elimination depends on ongoing community involvement.
- Use volunteers to complement, rather than replace, professional operations, providing appropriate training, quality assurance and ongoing support to maintain programme capability.

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12 High-level operational planning

This section translates the evidence-based design principles presented in Section 11 into high-level operational planning for Towards Predator-Free Taranaki (TPFT). The recommended actions provide practical guidance for planning, establishing, implementing and maintaining a multi-species elimination programme. The actions are organised into tables that reflect the typical progression of an elimination programme, from immediate priorities through to pre-implementation planning, programme scaling, implementation and long-term biosecurity. Although presented sequentially, many actions will occur concurrently and should be refined as operational experience is gained and new evidence becomes available.

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12.1 Immediate Priorities	Key actions
Define purpose & assess feasibility	• Define whether the programme objectives include elimination, elimination science, and/or biodiversity outcomes. • Define the operational, ecological, and success outcomes required to achieve the selected programme objectives. • Align programme design, monitoring and evaluation with the selected programme objectives. • Match programme scale to available operational capability and resources. • Assess the technical and operational feasibility of achieving the programme objectives. • Undertake a social feasibility assessment alongside technical feasibility assessments.
Understand the operational environment	• Develop an understanding of the ecology, distribution and habitat use of each target species*. • Assess the movement behaviour and detectability of each target species before designing surveillance and control systems*. • Identify predator–prey and other interspecific interactions relevant to Western Taranaki. • Evaluate whether species interactions reported elsewhere are likely to occur under local ecological conditions. • Identify likely reinvasion pathways, source populations and operational constraints before finalising programme design.
Plan operational trials	• Identify the critical uncertainties that must be resolved before large-scale implementation. • Design each operational trial to answer clearly defined questions that inform programme design, operational methods or decision-making. • Identify devices, baits and lures that require field validation before operational deployment.

** A proposed camera-trapping investigation to address these priority questions is provided in Appendix A.*

Determine species sequence	• Evaluate simultaneous and sequential elimination scenarios and compare the ecological, operational, financial and social implications of each scenario. • Identify which target species can be eliminated simultaneously using shared operational systems. • Assess how different elimination sequences influence biodiversity outcomes, species interactions, programme risk and reinvasion. • Select and document the preferred elimination sequence, including the rationale and assumptions underpinning the decision. • Develop contingency plans where species require different implementation schedules or cannot be eliminated as originally planned.
Establish phases	• Define the objectives for knockdown, mop-up and long-term biosecurity. • Specify surveillance approaches for each operational phase. • Define decision criteria and transition triggers between operational phases, recognising that these criteria should be refined as operational experience is gained.
Proof of success	• Define the evidence required to demonstrate elimination. • Establish confidence thresholds for operational decisions and declarations of success. • Specify the surveillance strategy required to achieve the defined confidence thresholds.
Reinvasion strategy	• Define how reinvasion will be detected, responded to and managed over the long term.
Define biodiversity outcomes	• Compare the expected biodiversity outcomes of elimination and sustained suppression relative to their costs and feasibility. • Select a management approach and intensity that is justified by the expected biodiversity outcomes. • Define biodiversity indicators that directly reflect the programme objectives. • Select indicators that measure both target-species responses and broader ecological restoration.
Build programme capability	• Establish the operational capability required to deliver the programme. • Build the specialist expertise required to support elimination. • Establish data management systems that support coordination and adaptive management.

Establish social license and access	• Identify key stakeholder groups, potential concerns, barriers to participation and opportunities for collaboration. • Develop a social license and communication strategy before operations commence, identifying stakeholder groups, engagement priorities, communication approaches, responsibilities and timelines. • Engage communities, iwi, hapū, landholders and partner organisations early in the planning process, before key operational decisions are made. • Involve communities in programme planning and decision-making from the outset. • Use social feasibility findings, local knowledge and stakeholder feedback to refine programme design and operational planning. • Establish a process for stakeholders to raise concerns and respond through targeted communication, broader engagement and, where appropriate, operational trials. • Develop long-term partnerships that support programme delivery and sustained community participation. • Identify all properties requiring access before operations begin. • Negotiate and maintain long-term access agreements with landholders. • Use local staff where possible to facilitate landholder relationships and secure property access.

12.2 Before Implementation	Key actions
Design surveillance and control systems	• Define surveillance objectives for knockdown, detect-and-respond, proof of absence and long-term biosecurity before designing surveillance and control systems. • Use modelling to optimise surveillance design, control coverage and proof-of-absence requirements before implementation. • Design integrated surveillance and control systems that meet the operational requirements of all target species, while incorporating species-specific methods where required. • Design surveillance and control around the ecology, movement behaviour and detectability of each target species rather than standardised operational layouts. • Determine surveillance spacing, device placement and density using the smallest expected home ranges of the target species, local environmental conditions and the objective of the programme. • Select surveillance methods, control tools, baits and lures that match the target species, operational objective and programme phase. • Design buffer systems using local movement, dispersal and reinvasion information, with specifications based on the species that is most difficult to contain. • Optimise baiting strategies through appropriate pre-feeding, bait coverage and lure selection to maximise bait acceptance. • Establish permanent surveillance infrastructure that supports elimination, reinvasion detection and long-term biosecurity. • Identify opportunities to integrate surveillance and control methods across target species without compromising species-specific surveillance or control requirements. • Incorporate species-specific surveillance and control methods where integrated systems do not adequately meet species-specific requirements.
Develop integrated operations	• Coordinate infrastructure, logistics, staffing and field operations across target species to minimise duplication and improve operational efficiency. • Identify the target species that presents the greatest surveillance and control challenge. • Design surveillance and control systems that meet the operational requirements of all target species. • Confirm that the resulting operational design also meets the

	surveillance and control requirements of all remaining target species.
Develop response systems	• Develop detection-response protocols for all target species. • Define surveillance and control actions that will be triggered following detections. • Scale response intensity according to the location, species and operational context of each detection. • Incorporate likely animal movement pathways into response planning. • Define surveillance triggers for initiating responses to reinvasion. • Develop operational procedures for responding to reinvasion detections.
Conduct operational trials	• Field-test surveillance tools, control methods, technologies, lures and operational approaches under representative Western Taranaki conditions. • Measure detection performance, operational practicality and cost. • Compare the performance of novel and existing methods using predefined performance measures. • Adopt operational methods only where field testing demonstrates benefits. • Refine surveillance and control design using field trial results and updated modelling where appropriate.
Design programme learning	• Develop a programme learning framework that records operational decisions, their rationale, implementation and outcomes throughout programme delivery. • Identify the priority management questions to be addressed through adaptive management. • Design monitoring to evaluate why operational approaches succeed or fail, not just whether programme objectives are achieved. • Establish biodiversity monitoring before implementation begins.

Prepare community delivery	• Record and manage property-specific operational requirements and access conditions. • Define the roles and responsibilities of volunteers within the programme. • Provide volunteers with appropriate training, resources and standard operating procedures. • Implement quality assurance processes for volunteer-delivered activities. • Establish community reporting pathways for suspected pest detections and other operational concerns, including processes for verification and operational response. • Provide ongoing communication, support and feedback to maintain long-term community participation.

12.3 Before Scaling	Key actions
Review programme readiness	• Review programme feasibility as operational experience and new information become available. • Confirm that operational capability, systems and resources are sufficient to support expansion. • Expand operations progressively as operational capability and confidence increase.
Refine operational design	• Review programme sequencing and define triggers for transitioning from simultaneous to sequential implementation if required. • Incorporate validated species interactions into programme design where they provide measurable operational benefits. • Incorporate operational learning into programme design before expanding operations.
Validate operational methods	• Evaluate trial outcomes against predefined performance criteria to determine whether methods are suitable for operational deployment. • Confirm that surveillance, control and operational methods perform as intended under operational conditions. • Confirm that validated methods are suitable for deployment at larger operational scales.

12.4 Throughout Implementation	Key actions
Adapt operations	• Review surveillance, operational and monitoring information routinely to identify opportunities for improvement and inform operational decision-making. • Adapt device placement, servicing schedules, resource allocation and operational responses in response to surveillance results and operational experience. • Maintain surveillance and control devices to a consistently high operational standard. • Modify baiting and lure strategies as operational phases, target populations and behavioural responses change. • Monitor programme outcomes to determine whether expected species interactions are occurring. • Refine integrated and species-specific operations in response to new evidence on species interactions. • Update surveillance, control, mop-up and biosecurity strategies in response to operational learning.
Programme review and improvement	• Capture and evaluate operational observations from field staff throughout programme implementation. • Use independent technical review to evaluate programme performance and identify opportunities for improvement. • Incorporate operational learning and new evidence into programme design and future operational decisions. • Review and refine operational phase criteria as operational experience is gained.
Mop-up operations	• Transition from broad-scale control to a targeted mop-up strategy once predefined operational criteria have been met. • Maintain an up-to-date picture of the distribution of remaining animals using surveillance information. • Continually reprioritise surveillance and control effort based on the location of remaining animals and recent detections. • Increase surveillance and control effort immediately following detections to remove remaining animals before breeding or dispersal occurs. • Introduce additional surveillance tools, control methods and lure types as required to target remaining individuals. • Review mop-up performance regularly and modify

	operational tactics where detections persist or progress slows.
Building confidence in elimination	• Implement the proof-of-absence framework throughout programme delivery. • Target surveillance towards areas of greatest uncertainty and reinvasion risk, reallocating effort as confidence changes. • Review confidence in elimination using surveillance results, proof-of-absence modelling, operational evidence and expert judgement. • Adjust surveillance effort and operational responses until the predefined confidence thresholds have been achieved.
Biodiversity monitoring	• Monitor biodiversity outcomes throughout programme delivery. • Report biodiversity outcomes to funders, partners and the community. • Review and update biodiversity indicators as programme objectives evolve.
Stakeholder engagement	• Maintain regular communication with communities, iwi, hapū, landholders and partner organisations throughout programme delivery. • Report operational progress, biodiversity outcomes and programme performance to maintain confidence and support. • Respond promptly to community concerns and adapt engagement approaches as programme needs change. • Maintain volunteer capability through ongoing coordination, communication and support.

12.5 Long-term Biosecurity	Key actions
Reinvasion management	• Maintain rapid detection and response capability for suspected reinvasions. • Record reinvasion detections, responses and outcomes to support continual improvement of long-term biosecurity. • Identify and distinguish surviving animals from reinvaders where possible. • Review and refine buffer systems, surveillance networks and response protocols as knowledge of reinvasion pathways and animal movement improves. • Use reinvasion events to identify weaknesses in biosecurity systems and implement corrective actions.
Long-term surveillance and diagnostics	• Maintain long-term surveillance following the declaration of elimination. • Maintain permanent surveillance at likely reinvasion pathways and other high-risk locations. • Use genetic and other appropriate diagnostic techniques to determine the origin of detected animals where possible.
Long-term community participation	• Review property ownership and access arrangements regularly and update access agreements where required. • Transition appropriate surveillance and biosecurity activities to trained community participants where practical. • Maintain community capability through ongoing training, resources and support. • Review community reports of suspected incursions and integrate verified detections into surveillance and response operations.

13 Species-specific operational guidance

This section complements the high-level operational planning presented in Section 12 by providing species-specific operational guidance for each target species. The recommendations summarise the key operational actions identified through the evidence synthesised in Sections 1-9 and are intended as a practical reference during programme design and implementation. As TPFT has already completed the initial possum knockdown, the possum guidance focuses primarily on mop-up operations.

13.1 Rats

13.1.1 Understand the population

- Confirm the identity, distribution and relative abundance of ship rats and Norway rats before designing surveillance and control operations.
- Design surveillance, control methods and device spacing specifically for the target rat species rather than applying a single operational approach.
- Collect genetic samples before eradication to support interpretation of any future detections and distinguish survivors from reinvaders where possible.

13.1.2 Surveillance and control

- Base device spacing on the smallest home ranges of the target rat species, expected rat density, habitat and programme objectives.
- Use approximately 25 × 25 m device spacing where uncertainty is high or rat densities are expected to be high (e.g. urban environments), and wider spacing (e.g. 50 × 50 m) where supported by operational evidence.
- Position devices along likely travel routes, habitat edges, linear features and other areas of concentrated rat activity.

Surveillance

- Use cameras as the primary surveillance method, supported by tracking tunnels, chew cards and wax tags to improve detection confidence.
- Deploy additional surveillance devices immediately following detections and around likely breeding locations.
- Prioritise detection of breeding populations where this is more practical than targeting individual dispersing rats, if the population can then be removed effectively.

Control

- Use broad-scale toxic baiting to achieve the initial population knockdown before transitioning to trapping.
- Confirm bait acceptance before commencing large-scale toxic operations.
- Reduce alternative food sources where practical to maximise bait uptake.
- Maintain complete bait coverage until all animals have had sufficient opportunity to encounter toxic bait.
- Match trap and bait station designs to the target rat species, selecting appropriate entry sizes, trigger mechanisms and trap dimensions.
- Secure traps to minimise sprung-but-empty events and reduce the likelihood of trap avoidance.

13.1.3 Mop-up

- Transition progressively from broad-scale baiting to targeted trapping and surveillance as rat density declines.
- Use rodent detection dogs to locate surviving rats, resolve uncertain detections and guide targeted device placement.
- Rotate bait formulations, lure types and trapping methods where operational performance declines or behavioural avoidance is suspected.
- Scale surveillance and control responses according to expected rat dispersal distances following detections.

13.1.4 Biosecurity

- Prioritise surveillance along likely invasion pathways and dispersal corridors.
- Design long-term surveillance to detect breeding populations rapidly and trigger timely management responses where ongoing elimination is the operational objective.
- Use genetic analysis to distinguish survivors from reinvaders and identify likely source populations where possible.
- Dissect captured rats to determine breeding status and assess whether reproduction has occurred.
- Treat juveniles detected more than approximately one year after eradication as evidence of recent breeding or reinvasion.

Alternative long-term management strategy

An alternative approach is to focus long-term surveillance on detecting and removing establishing breeding populations rather than attempting to detect every individual rat. Under this model, permanent control devices (e.g. long-life toxic lure devices) remain continuously deployed across the operational area, while surveillance is concentrated in high-risk locations and reinvasion pathways. This approach assumes that isolated incursions will encounter existing control devices, allowing surveillance effort to shift from demonstrating the absence of individuals to rapidly detecting and eliminating any population that begins to establish. Where appropriate, this strategy may substantially reduce long-term surveillance requirements and operational costs while maintaining elimination.

13.2 Cats

13.2.1 Understand the population

- Identify areas likely to support resident feral cats, including breeding habitat, den sites, reliable food sources and travel corridors, before installing surveillance and control networks.
- Conduct pre-operational surveillance to identify cat distribution, habitat use and movement patterns before designing surveillance and control operations.
- Identify properties with pet cats before operations and maintain an up-to-date register.
- Use the register to rapidly distinguish companion cats from potential feral cats following detections.
- Consider implementing a cat registration system (e.g. a 'Cat-alogue' similar to Tu Mai Taonga) that records photographs and distinguishing features of owned cats to assist identification of trapped cats.
- Consider providing pet cat owners with a visual identification aid (e.g. a high-visibility collar) to assist rapid identification of owned cats.
- Temporarily confine or otherwise manage owned cats during intensive operational periods where appropriate.

13.2.2 Surveillance and control

- Position devices along predictable travel routes and movement corridors.
- Base device spacing on local home-range size, movement patterns and surveillance information.
- Use approximately 300-400 m device spacing where local cat movement data are unavailable, adjusting spacing where supported by local evidence.
- Concentrate surveillance and control along fence lines, farm tracks, bush edges, ridgelines and other predictable movement corridors.
- Target habitat interfaces where cats move between cover and foraging areas, particularly forest-pasture edges and riparian margins.
- Minimise unnecessary human disturbance during surveillance and control operations.
- Use cat detection dogs to locate cat activity and guide targeted device placement.
- Schedule surveillance and trapping effort to account for seasonal changes in cat behaviour, prey availability and breeding biology.

Surveillence

- Establish cameras as the primary cat surveillance method.
- Supplement camera surveillance with detection dogs, community reports and other complementary detection methods.

Control

- Sequence control methods to minimise trap avoidance, reserving alternative trap types and specialised methods for cats remaining after initial control.
- Use cage traps as the primary cat control method.

- Install cage traps before activation to reduce neophobia.
- Leave cage traps in place and ensure they remain stable to reduce neophobia and trap avoidance.
- Introduce alternative trap types (e.g., leg holds) where primary trapping methods become ineffective or individual cats prove difficult to capture.
- Incorporate secondary poisoning opportunities where they provide operational benefits, but do not rely on secondary poisoning as the primary eradication method.
- Inspect and maintain traps regularly to minimise failures and escapes and promptly repair or replace poorly performing traps.
- Rotate lure types throughout operations to maintain attraction as prey availability and cat behaviour change.
- Cluster additional traps around repeatedly used movement corridors and high-activity locations.

13.2.3 Mop-up

- Retain at least one effective novel control method for mop-up operations (e.g., self-reporting leg hold traps or kill traps).
- Consider long-life lures during the final stages of elimination to reduce human disturbance.
- Use hunting dogs to locate or flush cats that are avoiding conventional control methods.
- Avoid educating surviving cats through unsuccessful capture attempts, excessive disturbance or repeated changes to trapping methods.
- Target control around repeated detections and established movement patterns, responding immediately to single detections only where delay is likely to reduce capture success.
- Assess the diet of captured cats to identify prey use and inform lure selection and operational planning.

13.3 Mustelids

13.3.1 Understand the population

- Confirm which mustelid species are present before designing surveillance and control operations.
- Develop separate surveillance and control strategies for stoats, ferrets and weasels.
- Base trapline and trap spacing on the smallest home ranges of the target species.
- Identify likely movement corridors and high-use travel routes before installing trap networks.

13.3.2 Surveillance and control

- Use experienced field staff or detection dogs to identify likely mustelid travel routes and guide device placement.
- Refine trap placement, density and servicing frequency using surveillance and capture data.

Surveillance

- Select surveillance methods based on demonstrated local performance.

- Validate cameras, tracking tunnels and other surveillance methods under local conditions before incorporating them into routine surveillance.

Control

- Match trap design, trigger settings, spacing and lures to the target mustelid species.
- Space stoat traplines no more than 400-500 m apart where eradication is the objective, with traps approximately 100-200 m apart along traplines unless local evidence supports an alternative design.
- Use substantially denser trap spacing for weasels than for stoats or ferrets.
- Position traps along waterways, coastlines, ridgelines, roads, tracks, bridges, culverts and other predictable movement corridors rather than uniform grids.
- Establish permanent trap networks where ongoing reinvasion risk exists.
- Increase trap density and servicing frequency in areas of repeated captures.
- Pre-bait stoat traps before activation.
- Use fresh meat lures, particularly rabbit, for stoats and ferrets unless local evidence indicates otherwise.
- Rotate lure types where capture performance declines.
- Service traps frequently enough to maintain fresh, attractive lures
- Review tunnel design, trap orientation, trigger sensitivity and trap presentation where capture rates are low.
- Select trap and tunnel designs that minimise non-target interference.
- Use lighter trigger weights for weasel traps.
- Incorporate secondary poisoning and PAPP only as complementary tools where operationally beneficial.

13.3.3 Biosecurity

- Use genetic information to identify likely source populations and reinvasion pathways.
- Maintain permanent and regularly serviced mustelid control networks to intercept reinvading animals.
- Prioritise surveillance and control along likely reinvasion pathways and dispersal corridors.
- Use genetic analysis to identify source populations and reinvasion pathways where possible.

13.4 Possums

13.4.1 Mop-up strategy

- Update the distribution of remaining possums using the latest surveillance information.
- Target surveillance and control towards recent detections while ensuring routine surveillance across the entire operational area.
- Consider targeted toxic baiting around remaining possums and along operational boundaries where appropriate.

- Establish possum nightclubs at sites with repeated detections by pre-feeding 4-6 inactive traps before activating them simultaneously.
- Use social lures to increase the likelihood of detecting or capturing the final remaining possums.

Surveillance

- Integrate detection dogs, cameras, wax tags and chew cards to maximise detection of low-density possums.
- Increase the use of detection dogs for routine surveillance and targeted removal.
- Increase camera density (e.g. to approximately one camera per 25 ha) where exceptionally high surveillance sensitivity is required, such as around recent detections or before declaring elimination.

Control

- Use current surveillance information and known possum movement patterns to position traps, recognising that trap placement is often more important than trap type.
- Concentrate trapping around repeated detections, feeding sites and high-use movement routes, repositioning traps as new detections refine possum distribution.
- Use long-life lures where they maintain lure attractiveness while reducing servicing requirements and human disturbance.
- If toxin bait is introduced, switch to substantially different bait formulations where bait acceptance declines or bait aversion is suspected.

Biosecurity

- Maintain surveillance and rapid response capability following elimination to detect and remove reinvading possums before they establish.
- Prioritise surveillance and control along likely reinvasion pathways, operational boundaries and known dispersal routes.
- Investigate every possum detection immediately to determine whether it represents a surviving individual or reinvasion.

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Appendix A: Camera-trapping to determine species distribution

Summary

To determine which species are present, where they occur, and how their distribution varies among habitats and across the landscape undertake a baseline camera-trapping survey across the TPFT zero footprint. Deploy a spatially balanced network of camera stations across all major habitat types, deliberately oversampling less extensive habitats to ensure adequate representation. Standardise camera placement, settings and lure deployment across all stations, with cameras operating for a minimum of seven consecutive nights. Record consistent site and detection information for every station to support mapping of species distributions and investigation of habitat and landscape associations. Where comparisons of cameras, lures or complementary surveillance methods are required, incorporate these as structured sub-trials within the baseline survey rather than allowing methods to vary systematically among sites.

Purpose

The camera trapping survey is intended to provide baseline information on the occurrence and distribution of the target species for elimination within the TPFT zero footprint. Specifically, the survey should:

- Determine which species are present.
- Describe how detections vary across different habitats and landscape settings.
- Identify broad habitat and landscape associations for each target species.
- Compare the performance of different camera models, lure systems or complementary detection methods, where appropriate.
- Provide evidence to inform future surveillance, control and camera network design.

The survey should be designed as a baseline distribution and habitat-association investigation, rather than an estimate of population size or density. The results will provide information on species occurrence and relative patterns of detection across the landscape to support operational planning.

Survey set up

1. Habitat stratification

Camera stations should be stratified across the major habitat types present within the project area. All major habitat types should be adequately represented, regardless of their proportional extent within the zero footprint. Less common habitat types should be oversampled where necessary to ensure sufficient representation. A practical habitat classification could be:

- Open pasture.
- Woody vegetation and scrub, including indigenous and exotic forest, mānuka/kānuka and gorse/broom.

- Riparian and freshwater vegetation (along waterways).
- Built-up, peri-urban and other modified land.
- Other productive land (e.g. orchards, vineyards or cropland), where sufficiently represented.

Where uncommon habitats occur as small, isolated patches, camera stations should be distributed among multiple patches rather than concentrated within a single location to avoid confounding habitat effects with site-specific characteristics. Within each habitat type, camera stations should be distributed across the entire zero footprint. Sampling should include:

- The original and extension blocks.
- Areas adjacent to the Kaitake Ranges.
- Interior and boundary locations.
- Coastal and inland areas.
- Sites close to and distant from urban centres.
- Areas with varying levels of community trapping and predator control.

Camera network

Candidate camera locations should be generated in GIS using a spatially balanced random or systematic design within each habitat type. Where a selected location is unsuitable, the camera may be relocated a short distance to the nearest suitable site while maintaining the intent of the sampling design. Large gaps in coverage and clusters of closely spaced cameras should be avoided unless they are required to adequately sample particular habitats.

The survey should use enough camera stations to provide repeated sampling within each broad habitat type and coverage across the main geographic areas of the zero footprint. As a practical minimum, aim for 8-10 stations in each broad habitat class. Additional stations should be added where needed to improve coverage or represent variation within a habitat class. The final number should be checked against the mapped distribution of habitats and candidate sites.

Where fewer cameras are available than the total number of required stations, cameras may be moved between sites in successive deployments using the same survey duration, lure and camera settings. Each deployment should include a representative mix of habitat types and geographic areas rather than surveying one part of the project area at a time.

Survey duration

Cameras should be deployed for a minimum of seven consecutive days at each site, with a 14-day deployment if operationally feasible (to improve the likelihood of detecting uncommon or low-density species).

Camera and lure placement

Cameras

A standardised camera placement protocol should be used at all survey sites to ensure detections are comparable across the survey.

Cameras should be mounted at a consistent height and distance from the lure station, with the exact configuration determined by the target species and camera model. Camera settings (e.g. sensitivity, trigger interval, image or video mode, burst length and night mode) should be standardised across all comparable cameras. Camera locations should be selected using the sampling design and by targeting obvious animal movement routes. For example, once a sampling location has been identified, by the sampling design, the camera may be relocated a short distance to the most suitable microsite.

Lures

The same lure should be used at every camera station. Where multiple lure types are required to target different species, the same combination should be used. Lures should be positioned consistently relative to the camera and maintained in an effective condition throughout the survey. Where lures require replacement, this should be done at consistent intervals using the same products and quantities at all stations.

Evaluation of surveillance methods

The primary objective of the camera survey is to determine species occurrence and distribution. Where TPFT wishes to compare alternative surveillance methods, these should be incorporated as structured sub-trials that do not compromise the consistency of the baseline survey.

Lure comparison

If different lure systems are to be evaluated, they should be incorporated as a structured sub-trial within the baseline survey. Paired lure treatments should be presented simultaneously at the same camera station, with the position of each lure standardised or randomised between sites. The paired stations should be distributed across the full range of habitats and landscape settings to ensure each lure is tested under comparable conditions.

Camera model comparison

Where more than one camera model is likely to be used operationally, their performance should be compared using paired deployments. Cameras should be positioned to monitor the same detection area using identical settings and lure treatments. Comparisons may include detection rates, time to first detection, image quality, battery performance, false triggers and equipment reliability.

Comparison with other surveillance methods

Wax tags, chew cards, tracking tunnels or other surveillance methods may be evaluated at a representative subset of camera stations. These methods should be deployed simultaneously with cameras and positioned within the camera's field of view so that animal interactions can be observed and verified. Comparisons should consider species detected, the frequency and type of interaction with each surveillance method, and the practical performance of each method under field conditions.

Data recording

A standardised data recording system should be used for all camera stations to ensure survey data are complete, consistent and suitable for subsequent analysis.

Site information

The following information should be recorded for each camera station:

- Unique station identifier.
- GPS coordinates.
- Deployment and retrieval dates.
- Habitat type.
- Original or extension block.
- Camera make, model, and serial number.
- Camera settings.
- Camera height and orientation.
- Lure type and deployment date.
- Site characteristics (e.g. track, fence line, habitat edge, surrounding vegetation and stock presence).

Landscape variables, such as distance to the project boundary, coastline, Kaitake Ranges, woody vegetation and waterways, should be derived from the final camera locations using GIS.

Station checks

Each camera inspection should record:

- Camera status and any malfunction.
- Battery or SD card replacement.
- Lure condition and replacement.
- Evidence of interference by stock, wildlife or people.
- Any notable observations, including evidence of species presence.

Detection records

For each independent detection event, record:

- Station identifier.
- Date and time.
- Species detected.
- Number of individuals, where identifiable.
- Behaviour (e.g. passing, investigating or interacting with the lure).
- Image or video reference.
- Any observations relevant to species identification or management (e.g. distinguishing features).

All images should be retained, and uncertain identifications should be reviewed and documented before analysis.

Analysis and reporting

The primary outputs of the survey should describe the occurrence and distribution of introduced mammal species across the TPFT zero footprint. At a minimum, the survey should report:

- The species detected.
- The proportion of camera stations detecting each species.
- Habitat and landscape features associated with detections of each species.
- Maps showing the location of detections for each species.
- Detection frequency and time to first detection for each species.

Where sufficient detections are obtained, habitat and landscape associations may be investigated using appropriate statistical analyses. If the data support more advanced analyses, occupancy models may be used to account for imperfect detection. Where detections are too infrequent for formal modelling, results should be presented using descriptive summaries and simpler statistical comparisons.

Method comparison trials (e.g. camera models, lure systems or complementary surveillance methods) should be analysed separately from the baseline survey and reported independently.

When interpreting the results, it is important to recognise that a lack of detections does not necessarily indicate species absence, particularly for uncommon or low-density species. Similarly, detection rates should not be interpreted as measures of population abundance unless this has been specifically investigated.

Appendix B: Resources and key contacts

Technical resources

A number of organisations have developed guidance and best-practice resources that are directly relevant to multi-species elimination programmes. Although many were developed for island eradications, the principles underpinning surveillance design, operational planning and eradication are broadly applicable to mainland elimination programmes.

Resource	Description
Department of Conservation (DOC)	Best-practice guidance for rodent eradication methods, including bait stations, hand-broadcast and aerial baiting.
Landcare Research Best Practice	Technical guidance covering surveillance, monitoring and pest management methods: https://pestdss.landcareresearch.co.nz/BestPractice
National Pest Control Agencies Publications	Technical standards and guidance for vertebrate pest management: https://www.bionet.nz/library/npca-publications
Predator Free Wellington – Urban Predator Free Blueprint	Practical guidance for designing urban rat elimination programmes: https://www.pfw.org.nz/trapping/knowledge-hub/our-urban-predator-free-blueprint-2024/
Island Eradication Advisory Group (DOC)	Developed many of the internationally recognised eradication principles and remains a valuable source of technical expertise.
Pacific Invasives Initiative	International guidance for rodent and feral cat eradication. Operational guidelines: https://pacificinvasivesinitiative.org/rce/tools/Guidelines.html Project planning framework: https://pacificinvasivesinitiative.org/rce/project/index.html

Recommended organisations and contacts

Several organisations and individuals were identified during the interviews as valuable sources of expertise for specific aspects of programme design and delivery.

Contact	Area of expertise
Predator Free Wellington	Data management and GIS systems; TrapNZ development; urban rat elimination; community engagement & social license; moving into rural rat elimination.
Te Korowai o Waiheke	Technical advisory groups; community engagement; team management; biodiversity monitoring; operational trials with rats
Tu Mai Taonga	Integrated databases and GIS; feral cat management where pet cats are present; Celium nodes.
ZIP (Zero Invasive Predators)	Rural rat elimination; bait station network design in a fragmented landscape; H2zero long-life toxic lures.
Predator Free Dunedin (Halo Project)	Integrating operational trials into programme delivery.
Cam Speedy	Operational team training.