Predator Free Rakiura Halfmoon Bay Project—biosecurity options

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PREDATOR FREE RAKIURA

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CONTENTS

Eradication [predator removal] is the simpler part of the pest-free equation. In contrast, biosecurity is open-ended and demands perpetual vigilance on multiple fronts for all manner of pest organisms (new and familiar), many of which may be cryptic or undetectable at low densities. Thus biosecurity is the greatest point of vulnerability in any pest-free project … That said, the biosecurity challenges in this project are formidable. Their scale and complexity will make this a pioneering project for New Zealand. If the challenges are met consistently and well, however, they have the potential to teach us a great deal. They will also extend biosecurity consciousness to audiences who traditionally have not had to think about the biological implications of movement between New Zealand's major landmasses.

Euan Kennedy (technical reviewer for this report).

Summary

The Predator Free Rakiura (PFR) Halfmoon Bay (HMB) Project proposes to greatly enhance biodiversity on Stewart Island/Rakiura (hereafter Rakiura) by permanently removing all predators (rats, possums, feral cats and hedgehogs) from an area around the township of Halfmoon Bay (Oban). Two project options are being considered: a larger option of approximately 4800 ha and a smaller option of approximately 2150 ha.

Once the predators were removed, substantial risks of predator incursion would remain, associated with breaches of the proposed predator fence and the movement of people, luggage and freight into the HMB Project area. Based on experience from similar projects elsewhere, incursions would be inevitable—of the fence in particular—and need to be managed accordingly. This document identifies and groups the incursion 'pathways' and 'vectors' according to their overall likelihood, with rats and mice the most likely to (re-)invade and the most difficult to remove. As a starting point for discussion, biosecurity activities and tools are proposed to prevent predator re-establishment. These can be grouped into three categories: quarantine, surveillance and response. Some of these activities (quarantine facilities and gear checking procedures) would need to begin prior to the predator removal phase.

A primary focus of this document (and the overall PFR programme) is to inform early consultation by the PFR Governance Group with Ngāi Tahu whānui, the Rakiura community, The Department of Conservation (DOC) and other key stakeholders about the proposed methods for predator removal and biosecurity. This report is not intended to be a biosecurity plan for the HMB Project. It therefore lacks significant detail in certain areas and associated cost estimates. In order for the PFR Governance Group to engage and consult meaningfully with the groups listed above, the process of developing the technical detail underpinning the work will be necessarily iterative; different groups should be encouraged as much as possible to develop their own biosecurity plans with support from the project team. This approach would allow for innovation from within each group, practicality and greater buy-in to the project as a whole. Further detailed planning and a thorough risk assessment (for the whole project) will be required in order the HMB Project to proceed beyond the concept stage.

This report does not deal with public and community engagement, although there is an urgent need for this work to take place. Promoting local involvement through shared leadership and ownership is fundamental to a successful biosecurity system and would be especially relevant to this project given the inclusion of Oban inside the proposed project area. Public education and engagement would need to be addressed through a communication and advocacy strategy for the wider PFR programme.

Removing predators from the HMB Project area would cost many millions of dollars and the cost of maintaining a predator-free state would, over time, be much more. The biosecurity activities proposed in this report are estimated to cost between $1.3 and $1.9 million dollars each year to undertake (depending on the size of the project area), with a need for substantial and additional contingency funds to remove any target species if and when they got back. However, without effective biosecurity systems, all previous investment would certainly be wasted. A community that supports this ambitious project would therefore need to carefully consider and endorse a new 'biosecurity culture' on Rakiura.

1. Background to biosecurity options for the Halfmoon Bay Project

1.1 What is the purpose of this document?

This report is one of four discussion papers that have been developed to help achieve the objectives of the HMB Project. Two other documents discuss the options for ground-based methods that could be used to remove predators [1] and the details of a predator fence [2] that would be required to help prevent predators moving back into the HMB Project area (Fig. 1). The third presents the estimated costs of undertaking this work [3]. In turn, these documents build upon the earlier work conducted by Brent Beaven [4] and by the collaboration formed between the Morgan Foundation and DOC [5].

A successful biosecurity programme for the HMB Project would require strong support from both the Rakiura community and visitors to the island. In particular, it would necessitate some changes to the activities of most individuals and businesses within the HMB Project area. Some of these changes have been outlined in a separate draft document [6]. Overall, this document is intended to provide some general ideas and guidance of how a successful biosecurity programme **could** be undertaken and what impact it might have on individuals or groups associated with the HMB Project area.

The overall biosecurity goal for the HMB Project would be:

To prevent predators from re-establishing inside the HMB Project area after they have been removed.

1.2 Which species are being targeted and why?

The focus of the HMB Project is on removing the group of predators that are currently inside the Project area (three species of rat, possums, feral cats and hedgehogs [1]) and preventing them from getting back. Mice are not believed to be established within the Project area at this time but have been regularly reported around Halfmoon Bay and so are also considered as a target species for the purpose of biosecurity. Although there is a lost opportunity in focusing biosecurity effort on mammalian predators alone, from the perspective of the PFR Governance Group this approach would make the project more realistic and achievable in both practical and financial terms and provide the greatest benefit to the island's biodiversity in the short term [4], [5]. There would also be wider benefits provided to the island's community and biodiversity by helping to prevent incursions of several other invasive species which have not established on the island, particularly stoats.

It must be stated, however, that the biosecurity focus on the target species listed above does not exclude the possibility of future biosecurity work to prevent other unwanted organisms entering the Rakiura environment (e.g. reptiles, invertebrates and plant pests); nor does it undermine the importance of historic and ongoing work to prevent the introduction or spread of many other organisms that could harm local biodiversity (e.g. Darwin's barberry and didymo).

The objectives of the HMB Project are considered achievable largely because of success (at least in the eradication / predator removal phase) in previous projects elsewhere [1] (Appendix 1); in particular, recent work on Rangitoto/Motutapu islands in the Hauraki Gulf. However, a biosecurity operation of this size and complexity, targeting multiple predator species in and around an established township with an abundance of incursion pathways, has not yet been successfully undertaken anywhere in the world [7]. If the HMB Project proceeds, the knowledge gained during

this work would help progress with similar or more ambitious projects elsewhere. It would also help the PFR Governance Group determine whether it is feasible to extend the predator removal operation to the rest of Rakiura [4], [5]. In this instance, the biosecurity systems already in place would provide most of the necessary infrastructure and activities for the much larger project. The HMB Project is likely to be more challenging from a biosecurity perspective than maintaining a predator-free Rakiura. It is therefore worth noting that if the HMB Project is not feasible or fails because of repeated breaches of the fence, this outcome is not necessarily a reason to abandon the goals of a programme to remove predators from all of Rakiura.

1.3 What have we learned from comparable projects in New Zealand?

New Zealanders have developed expertise in biosecurity management over the past several decades, mostly because of the country's high vulnerability to invasive species [7], [8]. Conservation projects have targeted increasingly larger areas and have eradicated a wide variety of introduced animal pests (Appendix 1) [9], [10], [11]. Most of the early eradication work focused on offshore islands, because they are often unpopulated and isolated from the mainland, so are relatively easier to defend. However, there is now considerable focus on mainland sites around New Zealand where the objective has necessarily shifted from eradication to removing mammalian pests and prevention and management of incursions (e.g. Maungatautari[1] in the Waikato, Zealandia in Wellington[2], Tawharanui[3] near Auckland and a local example on Rakiura—the Dancing Star Foundation's work on the peninsula between Lee Bay and Horseshoe Bay[4]).

Although having both mainland and true island similarities, the HMB Project (both options) should be considered a mainland site for biosecurity planning. The challenges associated with biosecurity on mainland sites are greater than for remote island sites. Continuous pressure from predators outside a fence, and in some cases (e.g. Tawharanui) the higher frequency of unregulated visitation of people (and their luggage), creates many opportunities for pest incursion and re-establishment. All of the projects listed in Appendix 1 have experienced incursions to some degree [2]. The permanent population of Oban on Rakiura also adds many additional pathways and vectors for incursion and some additional tests for responding to these challenges. Nonetheless, two projects within the size range of the two proposed HMB Project options, Maungatautari (3400 ha) and Rangitoto/Motutapu (3400 ha) have so far been successful at slowing incursions and preventing pests from re-establishing (Appendix 1). Rangitoto does not have a permanent human population, but does receive over one hundred thousand visitors each year[5].

During this new era in conservation there has been a great increase in knowledge of the efficacy of the control, surveillance and response tools necessary to achieve and maintain successful pest-free areas. Much of this knowledge has come from direct experience as projects have succeeded, failed, or needed substantial changes (i.e. adaptation) in management. In addition, there has been increased understanding of the resources required (money, tools and staff) and an increasingly strong link between scientific research in New Zealand and around the world [9], [10]. While pest removal and eradication projects can be undertaken in a relatively short period of time (several months to several years for some species), the associated biosecurity programmes are long-term commitments and must be delivered in perpetuity. Conversely, while programmes to eradicate

[1] www.maungatrust.org

[2] www.visitzealandia.com

[3] www.tossi.org.nz

[4] www.dancingstarfoundation.org/new_zealand.php

[5] www.doc.govt.nz

and remove species can be extremely costly (requiring substantial budgets), most ongoing biosecurity inputs are relatively low (or need to be in order for the project to be feasible in the long term and worth the initial investment).

New Zealand now has a large group of technical specialists, researchers and practitioners with direct experience of the many projects that have been undertaken to date. There has also been a growing acceptance and interest within communities internationally of the importance that pest- and/or predator-free environments provide to native biodiversity and associated opportunities for social and economic benefits [12].

2. Important biosecurity questions for the Halfmoon Bay Project

2.1 How could predators get back?

It is impossible for land-based predators to swim to Rakiura from the South Island, but there are still many ways that incursions could happen. The way a pest arrives in an area is described by an incursion pathway and vector. In this document, an incursion pathway is the process and route by which any rat, mouse, possum, cat, hedgehog, or mustelid (ferret, stoat, weasel) could move into the HMB Project area from outside of it (e.g. cargo, tourism, fishing, luggage, pet trade, hunting, natural dispersal by swimming or flying, etc.). A vector is any mechanism that could transport a target species into the HMB Project area (e.g. passenger and freight ferries, fishing vessels, recreational boats and aircraft). The boundary between the definitions of pathways and vectors is blurred, but it is helpful to distinguish between the two, as different management responses are required for each, with more attention on regulatory and policy requirements needed for pathways and more attention on management actions for vectors. Describing and understanding pathways and vectors is important for biosecurity management because it helps to identify points in time and space where activities can help prevent the progress of pests towards an unwanted destination (Fig. 1 and Table 1).

Although it is impossible to describe every possible incursion pathway and vector, three variables help to identify where biosecurity management is most useful. These variables can be seen as:

- **Pressure**: the density of target species at sources and the number of pathways to the HMB Project area;
- **Frequency**: the number of pathways or vectors that actually have a predator; and
- **Risk**: that an incursion leads to the establishment of a new population.

A combination of these variables allows the overall risk of different pathways and vectors to be estimated and prioritised. Activities can then be undertaken to prevent pest animals from progressing at various steps on the pathway. These activities, termed quarantine and surveillance, are needed to detect and respond at any location (e.g. at a departure point, on board a vessel, or at the destination), preferably before predators make it to the site and at very least before they establish a population. The pathways and vectors that are relevant to the HMB Project area are summarised in Table 1.

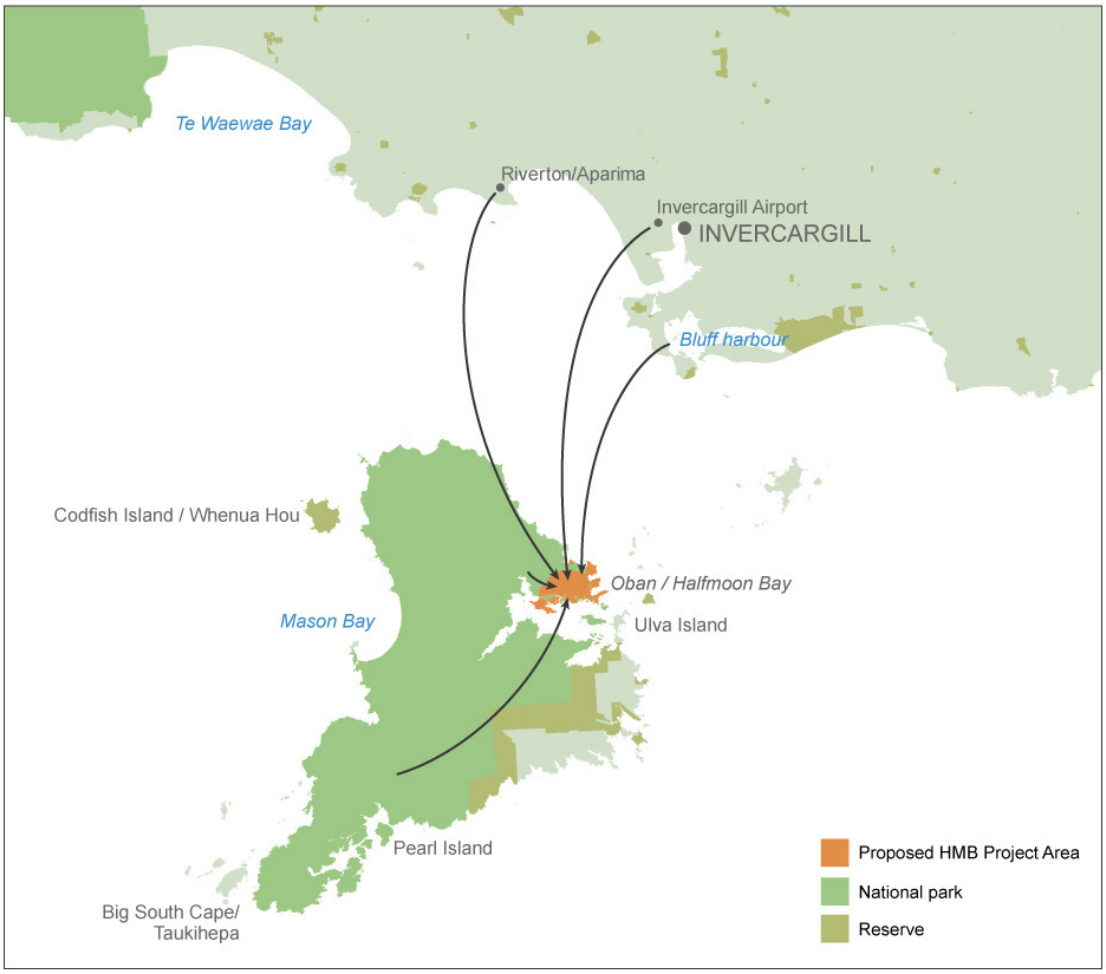

Figure 1. Map showing Stewart Island/Rakiura and the proposed 4800 ha Halfmoon Bay (HMB) Project area. Incursion pathways / vectors (arrows) are described in the text and Table 1. The same pathways and vectors would apply for the smaller 2150 ha operational area.

Table 1. Summary of biosecurity pathways and vectors that are relevant to the HMB Project area and their risk. Note: These pathways and vectors apply irrespective of whether the project area is 4800 ha or 2150 ha.

INCURSION PATHWAY OR VECTOR	TARGET PREDATORS	RISK	NOTES/JUSTIFICATION
New Zealand beech / podocarps / tussock heavy fruiting and seeding (mast) years	Rats and mice	Very high	Very high rat densities ('irruptions') occur periodically on Rakiura and elsewhere in response to heavy seeding or fruiting. The risk of most pathways/vectors below becomes much greater when there is a rat or mouse plague (= pressure as outlined above).
Bulk transfer of cargo to HMB from other ports (Bluff or otherwise) via large vessels (e.g. freight boat).	Rats, mice and (less likely) possums, cats, mustelids	High (for rats and mice) Low for other predators	Large boats can provide ideal temporary habitat for rats and mice. Vessels with **high risk*** freight travel frequently to HMB from Bluff.
Boats travelling to/from aquaculture areas.	Mice and rats	Medium	Frequent trips between HMB and aquaculture farms where mice have been reported [2]. The presence/absence of mice would be confirmed prior to predator removal [1].
Fence breached due to tree/branch falling over top/alongside, or causing direct damage to fence and providing temporary access.	Possums, cats, rats	Very high = certain	It would be impossible and/or inappropriate to remove all large vegetation from a buffer zone around a fence large enough to remove this risk, which would mean a high likelihood (over time) of a tree or branch falling on top of, or beside the fence. Cats can jump >1.8 m, rodents and possums are good climbers.

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Table 1 continued

INCURSION PATHWAY OR VECTOR	TARGET PREDATORS	RISK	NOTES/JUSTIFICATION
Around ends of fence.	Rats	Very high = certain	Rats can swim several hundred metres and the fence would not extend this far out into the water. Possums and cats are not included because they are both very reluctant and poor swimmers.
Commercial fishing vessels.	Rats and mice	Medium or high	Frequent visitors from around the South Island. Fishing boats frequently provide temporary habitat for rats [13] and mice and opportunities for them to transfer between mooring sites.
Cargo of large groups moving bulk equipment and supplies by boat.	Rats and mice	Medium or high	Groups regularly travel with large quantities of assorted gear (including **high-risk*** freight and cargo such as food, rubbish) into the HMB Project area from either the South Island or from other areas of Rakiura outside the fence. Collectively, these activities are a common occurrence. Risk is medium for regulated activities (e.g. government and research agencies) and high for unregulated activities (e.g. charter vessels with hunting or research parties that do not require authorisation for their activities).
Intentional release of predators and/or damage to fence.	Mustelids, cats, rats, mice, possums, hedgehogs, others.	Low or medium	Anonymous threats have been made to release predators on Rakiura and at other project sites around New Zealand. The risk will depend largely on the overall community support for the project.
Cruise ships moored close to Rakiura and in Paterson Inlet.	Rats and mice	Low	Large vessels can provide a refuge for rats and mice and large tourist vessels are becoming more frequent visitors to HMB. The low risk assumes tourist ships already have some form of biosecurity on board and that biosecurity measures would be part of any surface water resource consent that is required to be commercially operating within the HMB area.
Abandoned pets left in HMB Project area.	Cats	Low	Domestic cats have been abandoned on Rakiura in the past.
Domestic cats establishing new feral cat populations.	Cats	High	Only relevant if any local domestic cats are not de-sexed during removal phase.
Vessels that have run aground or sunk.	Rats and mice	Medium	Between 1950 and 1987, 40 fishing boats were lost around Rakiura, including 10 that ran aground inside the HMB Project area [14]. The risk of incursion is proportional to the vessel's size, what it is used for, and the proximity to HMB project shoreline.
Cargo being carried by helicopter (i.e. 'sling loads').	Rats and mice	Medium	Common activity into and out of HMB often transporting large quantities of **high-risk*** cargo and sometimes mixed materials (e.g. building supplies plus food or rubbish). Some trips would also be arriving from other areas of Rakiura with high rat abundance (e.g. hunting camps and huts).
Luggage (suitcases and packs) belonging to residents and visitors who enter the HMB Project area.	Rats and mice	Low to Medium	Individually, luggage being transported would be low-risk, but the high frequency of movements increases the risk.
Large quantities of supplies and/or **high-risk*** items accompanying residents and visitors.	Rats and mice	Medium	Moderate frequency of trips to/from mainland and often with **high-risk*** mixed cargo.
Large cargo/container ships moored near HMB Project area	Rats and mice	Low	Large vessels can be a refuge for rats and mice, but container ships are uncommon visitors and seldom moor within rodent-swimming range of the HMB Project area.

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Table 1 continued

INCURSION PATHWAY OR VECTOR	TARGET PREDATORS	RISK	NOTES/JUSTIFICATION
Water taxis	Rats	Low to Medium	Water taxis are small vessels with little permanent gear stowed on board. Risk could increase with location of mooring sites, or during times of high rat abundance.
Trampers' packs when returning to the HMB Project area from elsewhere on the island.	Rats	Low	Trampers pack and carry their own gear resulting in a small volume of gear which is packed methodically on the same day and often checked.
Other vessels (e.g. research, oil exploration, Navy ships).	Rats and mice	Low to Medium	Infrequent events that may need to be assessed individually.

* Examples of high-risk freight and cargo include any items where there is a possibility of a rodent being present prior to transporting to HMB, including bulk food / salmon food, certain landscaping and garden supplies (e.g. pea straw, compost, bark chip), vehicles and machinery, building supplies, furniture and household goods

2.2 How could predators be prevented from re-establishing?

Minimising the risk of predators re-establishing within the HMB Project area could be achieved using a series of activities, interventions and tools at various stages of the incursion pathways listed above. These activities fall into three groups: quarantine, surveillance and response.

- The aim of quarantine is to **prevent** the target predators from getting on and off a pathway or vector (e.g. getting on a boat or plane), thereby eliminating or removing the risk of incursion.
- The aim of surveillance is to **detect** all predators that have arrived in the HMB Project area before they can establish a self-sustaining population.
- The aim of a response programme is to **kill** any predators that have arrived, regardless of whether they have established a population.

NB. These two latter activity groups are sometimes combined and referred to as 'early detection and rapid response', or 'EDRR' [6].

For the HMB Project, these activities would most likely consist of purpose-built facilities at key sites, quarantine and surveillance by trained staff, and associated networks of surveillance devices, traps and bait stations. While containment and inspection of medium-to-high-risk cargo at some point along an incursion pathway is essential, it is accepted that purpose-built facilities may not be feasible at all of the suggested locations (Table 2) and that further additional changes to operations or best practice will required. The use of dogs trained to detect rats, mice and other predators would also be relevant to practically all of the proposed biosecurity work, so they are considered in this document as a special case.

Most of the activities would be undertaken or administered by PFR staff, but would require consultation and input from residents, businesses associated with the HMB Project area, and local government authorities. An advocacy and education programme would also be developed to compliment proposed biosecurity activities and to maintain an ongoing and transparent relationship with the community.

[6] Centre for Invasive Species and Ecosystem Health 2012. Early Detection and Rapid Response (EDRR) http://invasive.org/edrr/index.cfm

There is a common belief that management at all points along the risk chain is optimal [9]. This is true across the whole biosecurity process and may be true for each risk species when funds are not constrained … However, funds are usually limited and managers have to allocate all or most of their resources to the most effective point(s), for each type of risk or species, along the chain. This optimal intervention point varies with the nature of the species, the likelihood of an 'event', the cost to detect it, the cost of dealing with any detection at different points along the chain, and the consequences and costs of a late detection or slow response on the island.

John Parkes

Best practice argues emphatically for quarantine at source or points of departure rather than on arrival. The latter can be simpler or cheaper but it does not deal to pest intruders until they are already within the boundaries of defended areas. Quarantine on arrival compromises biosecurity in other ways, such as by reducing checking to a single opportunity, arguably when it may be too late, and by limiting options for dealing with contamination and disposal of pests.

That said, biosecurity challenges for the Halfmoon Bay Project are amplified enormously by having to shut down risk pathways at multiple points of departure to Stewart Island, some beyond the project's quarantine reach (i.e. ports further afield than Southland). Accordingly, pre-border quarantine measures will impose a huge strain on the project itself and its resourcing.

Euan Kennedy

2.2.1 Quarantine

A thorough risk assessment would be required to help determine whether quarantine would be best achieved by focussing on arrival points, or both departure and arrival points. As a starting point for planning the HMB Project, it is proposed that quarantine measures consist of interventions at multiple points along the pathway (i.e. both departure and arrival).

Under this scenario, routine checks of luggage and gear by trained staff with predator-detection dogs and purpose-built facilities would be required at five key areas: the Bluff and HMB wharves, Invercargill Airport, the Stewart Island airfield and the Fern Gully heliport. These facilities would be needed because they represent the departure and arrival points for the majority of trips to the HMB Project area and therefore provide the best chances to intercept predators. For some locations, a facility known as a containment area would be required from which any animal detected could not escape. These facilities (**fully contained areas, fenced areas or, in some cases, just containment bins**) would also allow checked gear to be stored safely. A special trapping tool known as a kick board can be included inside a secure fence around a containment area to kill a rat or mouse if found. These facilities on the island are considered as quarantine (rather than surveillance) because they would need to be built to a high enough standard to be considered as 'pre-border'.

A very preliminary proposal for facility and staff requirements is presented in reference [3], together with the relevant business/es that would be directly affected by these requirements. Full details, specification and costs of any upgrades to facilities would need to be developed in conjunction with site owner/operators and agreement reached among all parties. Similarly, minimum standards for staff training and work requirements at the different locations would need to be developed in partnership with owner/operators.

All quarantine facilities and systems, including the phasing in of gear checks, would need to be established well before the commencement of predator removal work. This approach would allow

Table 2. Summary of proposed high-level quarantine requirements at five locations associated with the HMB Project. 'Inspections' would be assessed on a case-by-case basis and could include brief questions, checks by detection dogs or more intensive checks of larger quantities of high-risk* freight and cargo.

LOCATION	BUSINESSES	SUGGESTED QUARANTINE REQUIREMENTS	ADDITIONAL BIOSECURITY
Bluff ferry terminal	Southport, Real Journeys and others	A large, clear, covered area for luggage to be inspected by trained staff, including dog handler with rodent-detection dog when available. Luggage would need to be immediately transferred to large impermeable containment bins prior to loading. If required, any searching of personal gear would be conducted in a private area and only with permission of the owner. Situations where further inspection might be required could be when a rodent-detection dog indicated possible sign of rodents in luggage.	Surrounding area (passenger terminal, adjacent wharf facilities) would require trapping and bait stations managed by trained staff. NB. Some trapping already occurs around the wharf which could be incorporated into a more rigorous programme.
Bluff Wharf, including freight terminal	Southport, Rakiura Shipping, commercial fishing boats and others	A rodent-detection dog and handler would be required to inspect all high-risk* freight prior to departure for Halfmoon Bay. The freight wharf at Bluff may require a purpose-built store capable of managing and holding large quantities of bulk materials and machinery. Risk assessments for different types of fishing activities would be required to determine if changes in current practice would be required to mitigate risk.	Surrounding area (adjacent wharf facilities) would require trapping and bait stations managed by trained staff. NB. Some trapping already occurs around the wharf which could be incorporated into a more rigorous programme.
HMB Wharf	Real Journeys, Southern Seafoods, Southport and others	A solution for the containment of high-risk freight and luggage that has not been inspected at the point of departure. Containment would be for the purpose of inspections by trained staff and predator-detection dogs (for rodents and other predators when dogs were available). If it is not feasible to construct a containment facility at this site at the HMB wharf then inspections would be required on-board vessels prior to unloading.	The immediate area surrounding the HMB Wharf (plus other wharves at Horseshoe Bay and Golden Bay) would be subject to an intensive trapping and bait station programme managed by trained staff.
Invercargill Airport	Invercargill Airport Ltd., Stewart Island Flights, Heli South, Southern Lakes Helicopters and others	Stewart Island Flights passenger luggage to be inspected by trained staff, including a dog handler with rodent-detection dog when available. Once cleared, luggage would need to be immediately transferred to large impermeable containment bins prior to loading. Larger loads to be carried by helicopter would require similar inspection immediately prior to flying.	Surrounding area (passenger terminals, helicopter hangars, and all airport facilities) would be subject to trapping and bait station programme managed by trained staff. This work would be an extension of activities already undertaken by Stewart Island Flights.
Ryans Creek Airfield	Stewart Island Flights, private aircraft, helicopter operators	A small containment/ fenced area where high-risk gear is unloaded from flights and inspected by trained staff with a rodent-detection dog prior to goods and luggage being distributed further on the island. This area would only need to be large enough to accommodate the space where the planes (sometimes two) stop/manoeuvre and vans park. Helicopter sling loads could also use the facility.	Surrounding areas would be subject to trapping and bait station programme managed by trained staff. This work would be an extension of activities already undertaken around the airstrip by Stewart Island Flights.
Fern Gully Heliport	All helicopter companies flying to HMB Project area plus the heliport owner	All helicopters landing inside the HMB Project area carrying high-risk loads would be required to land inside a specified containment area for gear to be inspected by trained staff and rodent-detection dogs. This area could either be at a new area at the existing heliport, or a shared facility (as described above) at Ryan's Creek airstrip.	Surrounding areas would be subject to trapping and bait station programme managed by trained staff. Other Southland-based helicopter hangars, e.g. at Te Anau or Tuatapere, would be encouraged to set up or continue with bait station and trapping programmes with help from trained staff as required.

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Table 2 continued

LOCATION	BUSINESSES	SUGGESTED QUARANTINE REQUIREMENTS	ADDITIONAL BIOSECURITY
All locations above	All of above	A large, clear covered area for luggage to be inspected by a dog handler with predator-detection dogs (stoats, cats, etc.) when available or deemed required.	

* Examples of high-risk freight and cargo include any items where there is a possibility of a rodent being present prior to transporting to HMB, including: bulk food / salmon food, certain landscaping and garden supplies (e.g. pea straw, compost, bark chip), vehicles and machinery, building supplies, furniture and house-hold goods.

systems to be tested and modified, if necessary. These facilities would also represent the *...public face of the biosecurity programme ... and must convey the right messages to communities and visitors, so professionalism and efficiency are important...* (E. Kennedy pers. comm.).

2.2.2 Predator-detection dogs

Trained predator-detection dogs are now a routine and important part of all biosecurity work around New Zealand and are regularly used in conservation programmes[7] [15], [16], always in conjunction with other detection tools. These specialised dogs operate by smelling the scent trails left by predators and would be required to work both on land and on vessels moored at sea. When properly trained, they would provide a detection tool that is both independent of and complementary to the use of all other detection tools (tracking tunnels, chew cards, traps, bait stations and visual inspections). Recent work at Maungatautari and elsewhere (Table 3) testing dog efficacy suggested that properly-trained rodent detection dogs are a much more reliable tool for surveillance (i.e. they are more likely to detect a predator) than other detection devices.

Table 3. Probability of detection using different devices.

PREDATOR	DETECTION DEVICE	DETECTION PROBABILITY	NOTES	REFERENCE
Ship rat—*Rattus rattus*	Live trap	2–11% 2–4%	Assumes detection device is in the centre of the animal's home range. Probability for 1 day. Both NZ study sites.	[16][7]
	Wax tags	17–22%	Assumes detection device is in the centre of the animal's home range. Probability for 1 day. Mexico study site.	[17]
Norway rat—*Rattus norvegicus*	Dogs	87%	Probability of detection given 360 minutes over 32 ha. NZ study site (Maungatautari)	[15]
Mice *Mus musculus*	Dogs	80%	Probability of detection given 360 minutes over 32 ha. NZ study site (Maungatautari).	[15]
Cats *Felis catus*	Camera trap	<1%	Assumes detection device is in the centre of the animal's home range. Probability for 1 day. Australian study site.	[18]
Possums *Trichosurus vulpecula*	Leg-hold trap	5%	Assumes detection device is in the centre of the animal's home range. Probability for 1 day. NZ study site.	[19]
Foxes *Vulpes vulpes* faecal scats as a template for finding cat scats	Dogs	10–40%	Probability of detection given 30 minutes over 100 ha. Tasmanian study site.	[20]
	People	<10%	Probability of detection given 30 minutes over 100 ha. Tasmanian study site.	[20]

[7] Ministry for Primary Industries. MPI Detector Dog Programme. http://www.biosecurity.govt.nz/biosec/camp-acts/detector-dog (accessed 4 October 2014).

Therefore, dogs could be the last line of detection where other tools were either unavailable (e.g. not present on a visiting tourist boat or private vessel) or failed to detect incursions (e.g. because a predator did not encounter and/or interact with a device). They could also be part of the first line of response in delineating areas of incursion if and when they do occur.

Given the high likelihood of rat and mouse incursions compared with other predators (Table 1), most of the predator-detection work at arrival points would need to be focussed on rodents. Properly-trained rodent dogs can detect all three species of rats and mice equally well, but other predator dogs are generally trained to detect only a single species (e.g. stoats).

The rodent-detection dogs would need to be based permanently on the island, assuming the DOC predator-dog programme [15] could be called upon to respond to requests for detecting other predators. This DOC programme has considerable experience working in island biosecurity and would be an essential ally for the HMB Project. It is a strong possibility that DOC would support this proposal, provided they are given enough time and proper consultation (E. Kennedy pers. comm.). Detection dogs for cats, mustelids, hedgehogs and possums would need to be available for regular, but less frequent, surveys of the surveillance network (especially along the fence), and to respond quickly (<48 hours) if incursion was suspected. Given the need for communication between DOC and PFR, this aspect of work has not been budgeted at this stage.

Considerable resources (several hundred thousand dollars) and time (up to 2 years) would be required for properly training predator-detection dogs and handlers for the HMB Project [21] and caring for them once work begins. A very preliminary estimate of the number of trained rodent detection dog teams required for the whole project is likely to exceed ten. This estimate is based on the time required to check each of the surveillance zones (including quarantine) at specified frequencies (described below).

Overall, the dog programme (for detection and predator removal) would need to be developed as a separate body of work but seen as integral to all other parts of the HMB Project—predator removal, biosecurity and advocacy. During the development of this work, consideration needs to be given to the capacity of dogs to operate across each of these different aspects of the HMB Project; and also to how much PFR can rely on the DOC programme to provide resources.

2.2.3 Surveillance

The overall goal of surveillance is to detect incursions using detection devices before any target predators can establish a population. Estimating the cost of different detection devices deployed at varying distances from one another and optimising the frequency of checks of devices is straightforward to plan (see Appendix 2). However, *interpreting a lack of detection using these devices and arrays is key, and that is not so simple* (J. Parkes pers. comm.).

All devices have limitations, such as only being able to detect one species out of many, or not being attractive to every individual of a species (see Appendix 3). Animal populations also exhibit a wide variety of behaviour (e.g. in the size of an individual's home range, movement, feeding, and lack of interaction with new devices (neophobia) [22], [23]). Device performance can therefore depend on many factors and is harder to evaluate. The proposed solution for the HMB Project is therefore to:

- Use a small selection of the best tools available (Appendix 3), thereby attempting to minimise the risks (= inadequacies) associated with any one device;
- Set these tools up in such a way as to target the most likely points of invasion, but also cover the entire area of the HMB Project;
- Check devices at a frequency that reflects the risk associated with the area; and
- Ensure that all tools are maintained to a high standard.

2.3 Which surveillance tools should be used?

2.3.1 Specific tools

1. Tracking tunnels for rats and mice

Tracking tunnels [24] are inexpensive widely-used and effective at detecting an animal's presence. The device (Fig. 2a) consists of a tunnel which contains a replaceable card with ink in the middle. Tunnels are usually baited at each end with peanut butter and left for 7 days before being collected. For this project, it is suggested that this interval should be less (e.g. 3 days) to reflect the urgency of responding to any detections. They are only reliable for detecting rodents (and sometimes hedgehogs and mustelids) which run through and leave footprints (Fig. 2b).

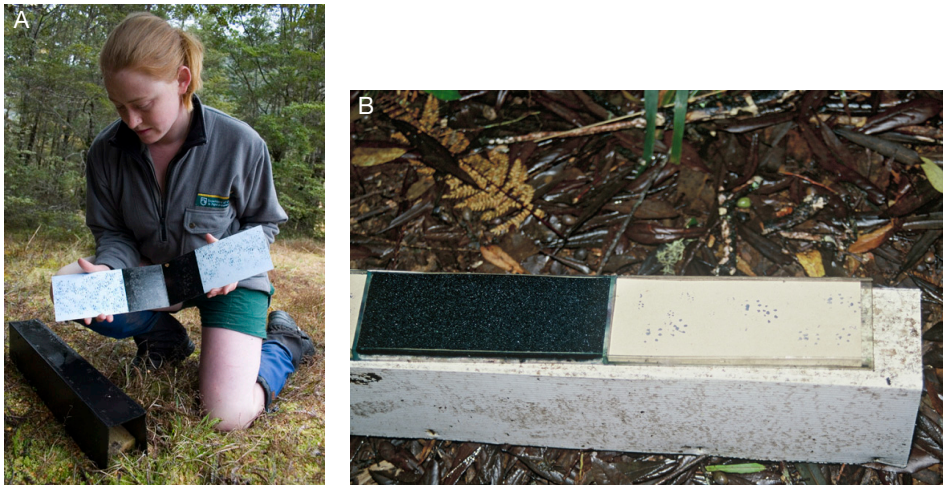

Figure 2. A. Setting a tracking tunnel and B. footprints on a card. *Images: DOC*

2. Chew cards for rats, mice, possums, and hedgehogs

Chew cards [25] which are made of plastic corflute, are very inexpensive and easy to deploy, use and interpret. Cards are usually baited with peanut butter and nailed to a tree until collection after a short interval (suggested as < 3 days for this project). They allow the detection of multiple species (sometimes simultaneously on the same card) by examination of chew marks and patterns left on the card. Different species' chew marks are easy to distinguish and chew cards are more sensitive than tracking tunnels and other devices for detecting both rats and mice, particularly if/when they are in low densities [20].

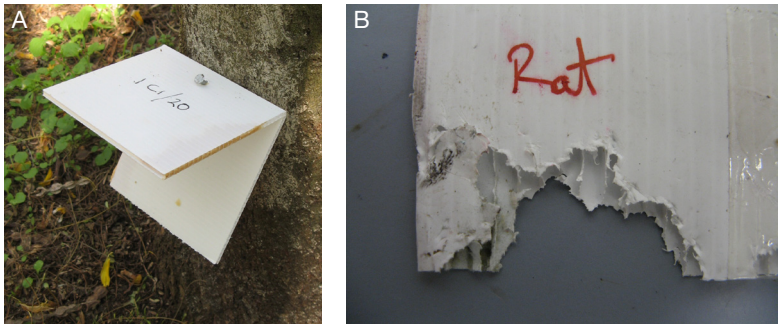

Figure 3. A. Chew card set on tree and B. the result of rat gnawing. *Images: Landcare Research*

3. Detection dogs for rats, mice, cats, possums, hedgehogs and mustelids

Predator-detection dogs (Fig. 4) are specially-trained dogs that provide an independent detection tool (e.g. for detecting sign of neophobic individuals that will not interact with surveillance devices such as traps, tunnels or cards). All detection dogs are expensive to train [21] (Table 4) and are only trained to detect one species (apart from rodent detection dogs, which usually cannot distinguish between any species of rats and/or mice). They are the only realistic option for detecting cats, aside from the use of trail cameras. Detection dogs would also form a vital component of quarantine and incursion response for the HMB Project.

Figure 4. Rodent detection dog. *Image: detectorgadget.blogspot.com*

4. Bait stations for rats, mice and possums

Figure 5. 'Philproof' bait station typically used for predator removal and control. *Image: DOC*

Bait stations (Fig. 5) provide both a surveillance and response tool that can remain in place but require regular checking and maintenance [1]. The bait used for rats and mice would be larger blocks which can be attached to the station and prevent them being carried away; larger quantities of free-flowing bait would be used for targeting possums [1]. Baits containing anti-coagulant toxins (e.g. brodifacoum or diphacinone) would be used for this work [1]. The disadvantages of using toxic bait are that the animal which has consumed it will not be present to confirm mortality or which species has consumed the bait.

5. DOC 200™ kill traps paired with a mouse trap for rats and mice

Figure 6. DOC200™ predator trap. *Image: predatortraps.co.nz*

Kill traps provide a surveillance and response tool and the 'DOC series' kill traps (Fig. 6) are very effective and humane[8]. These traps require a purpose-built box (one for both traps) for setting and protection. The DOC 200™ kill traps could also be used to target mustelids and hedgehogs, if required, but should be set so that mice are unable to interfere with them.

[8] www.predatortraps.com

6. Trail cameras for all species

Remote trail cameras (or cameras 'traps') [26] use motion detectors to capture images (or video footage) of animals (Fig. 7a, b, c). They are expensive (several hundred dollars), but unlike all other devices they do not require an animal to 'interact' with a device. As well as providing their own data, cameras should be used specifically to check that other surveillance tools are working. This check can be achieved simply by having a trap, tunnel, card or bait station clearly in the photo frame.

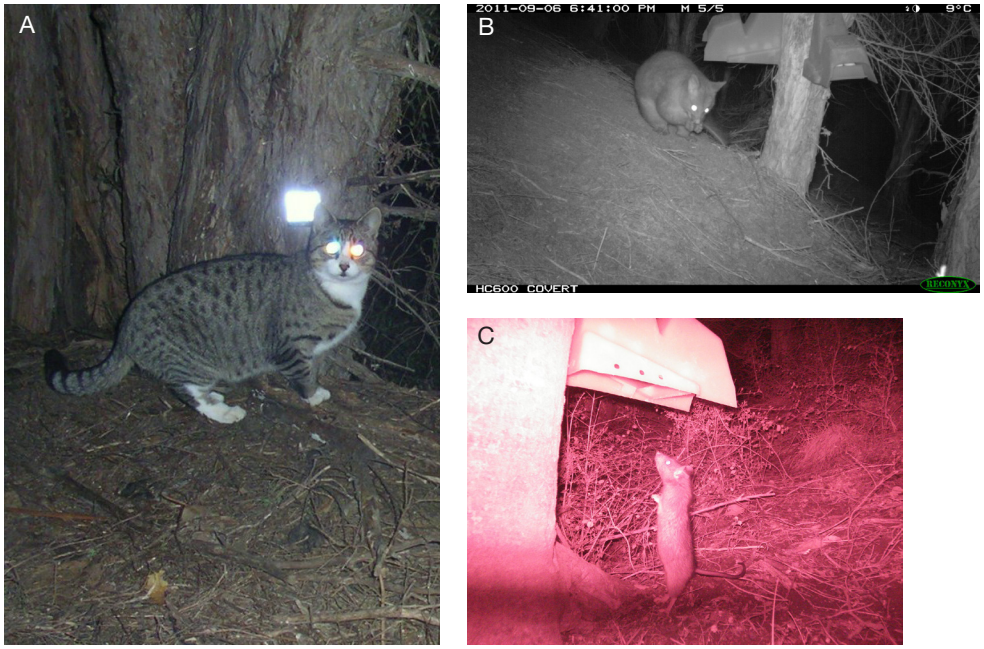

Figure 7. Photographs taken from motion-activated cameras. A. Domestic cat, B. possum, C. rat.
Images: Landcare Research, Lincoln University

7. Passive surveillance

A simple 'hotline' could be established for any informal reporting of sightings and/or sign of predators.

2.3.2 Working with the community

A fundamental part of biosecurity for the HMB Project would involve working closely with the local community on private property and vessels. Most of the activities proposed in this document are straightforward and could be performed or administered by PFR staff and/or the businesses responsible for carrying passengers and gear, creating minimal disruption to residents' daily lives. However, some properties or vessels may also require more specific solutions due to the higher level of risk that they present (e.g. because of their size, or the presence of food, rubbish or building structures). In these cases it would be highly advisable to establish and agree upon clear site- or vessel-specific biosecurity plans, with communication, guidance and support from PFR staff as required. This work could build upon, or be combined with the proposed 'property action plans' which are discussed in the methods paper [1] and would also need to part of a communication/advocacy strategy.

A 'model' biosecurity programme for islands with high visitation rates is currently operating in the Hauraki Gulf, the 'pest-free warrant' system[9]. A similar programme of 'predator-free warrants' specific to vessels in the HMB Project area is outlined in Appendix 4. The proposed warrant programme and property action plans would be voluntary to enter, and in most cases would

[9] www.treasureislands.co.nz

consist of a brief questionnaire and follow-up visit by PFR staff with a rodent-detection dog to identify properties and vessels that have high biosecurity risks for the HMB Project. Owner/operators would then be provided with suggestions to mitigate risks (e.g. where and how to set up bait stations or traps, how often to check them and what to do with results). Most of this work would happen prior to the beginning of the predator removal work and would be regularly audited by PFR staff in future years.

Some of the benefits to participants in this programme would come from:

1. Being able to rely on the advice, experience and consistency provided by trained staff;
2. Provision of reliable equipment (e.g. for surveillance and/or control) with clear instruction on use and maintenance;
3. Regular communication and updates from PFR staff;
4. Market incentive for tourist and other service providers.

How and where would surveillance be conducted?

Surveillance Zones

Identifying areas for surveillance has been based on the pathways and vectors identified in Table 1. Some areas within the HMB Project area (both project options) are associated with a greater (or lesser) likelihood of incursion (or 'risk') and it is proposed they are grouped into different 'zones' (Fig. 8).

- **Quarantine zone**—This zone includes the sites of common departure and arrival for journeys to and from the HMB Project area (Bluff Wharf, Invercargill Airport, HMB Wharf, HMB airfield, the Fern Gully helicopter hangar and the Golden Bay Wharf). These are high-risk sites.
- **Town zone**—This is the area surrounding the township of Oban, plus all associated infrastructure (roads, dwellings and facilities) and areas of frequent human activity (tracks and shelters) within the HMB Project area. It is approximately 1200 ha irrespective of the overall size of the Project area (or 1000 ha excluding the Dancing Star reserve) and, overall, is a high-risk area. Some sites within the town zone would be considered as preferred establishment places for rats and mice (e.g. private/public wharves, food storage areas, rubbish dumps/transfer stations etc.). These sites would be highly beneficial for concentrating surveillance within the town zone and could be identified during surveys undertaken as part of the proposed 'property action plans'.
- **Coastal zone**—This is a 500 m buffer totalling approximately 1060 ha along the coastline of the 4800 ha Project area, or a much smaller 100 ha zone for the 2150 ha Project area. It is a medium-risk area due to the possibility of rodent incursions from vessels that moor, land or wreck nearby.
- **Fence buffer zone**—This zone is a 500 m buffer on either side of the proposed predator fence and equates to approximately 880 ha for the 4800 ha Project area and 700 ha for the 2150 ha Project area. Control using the same tools as for predator removal [1] would be undertaken along the outside of the predator fence (approximately 440 ha for the 4800 ha Project fence and 360 ha for the 2150 ha Project fence). This approach would help reduce local predator abundance and aim to decrease the likelihood of an incursion through or around the ends of the fence. This piece of work would need to be considered in more detail once the tools for predator removal have been determined, especially in light of the potential ongoing use of toxins. On the inside of the fence (approximately 440 ha for the 4800 ha Project and 340 ha for the 2150 ha Project), surveillance would be conducted to respond quickly to detection of holes in the fence and detection of animals that get through them or around the ends. The fence zone would be a high-risk area overall and the ends of the fence would be very-high-risk areas.

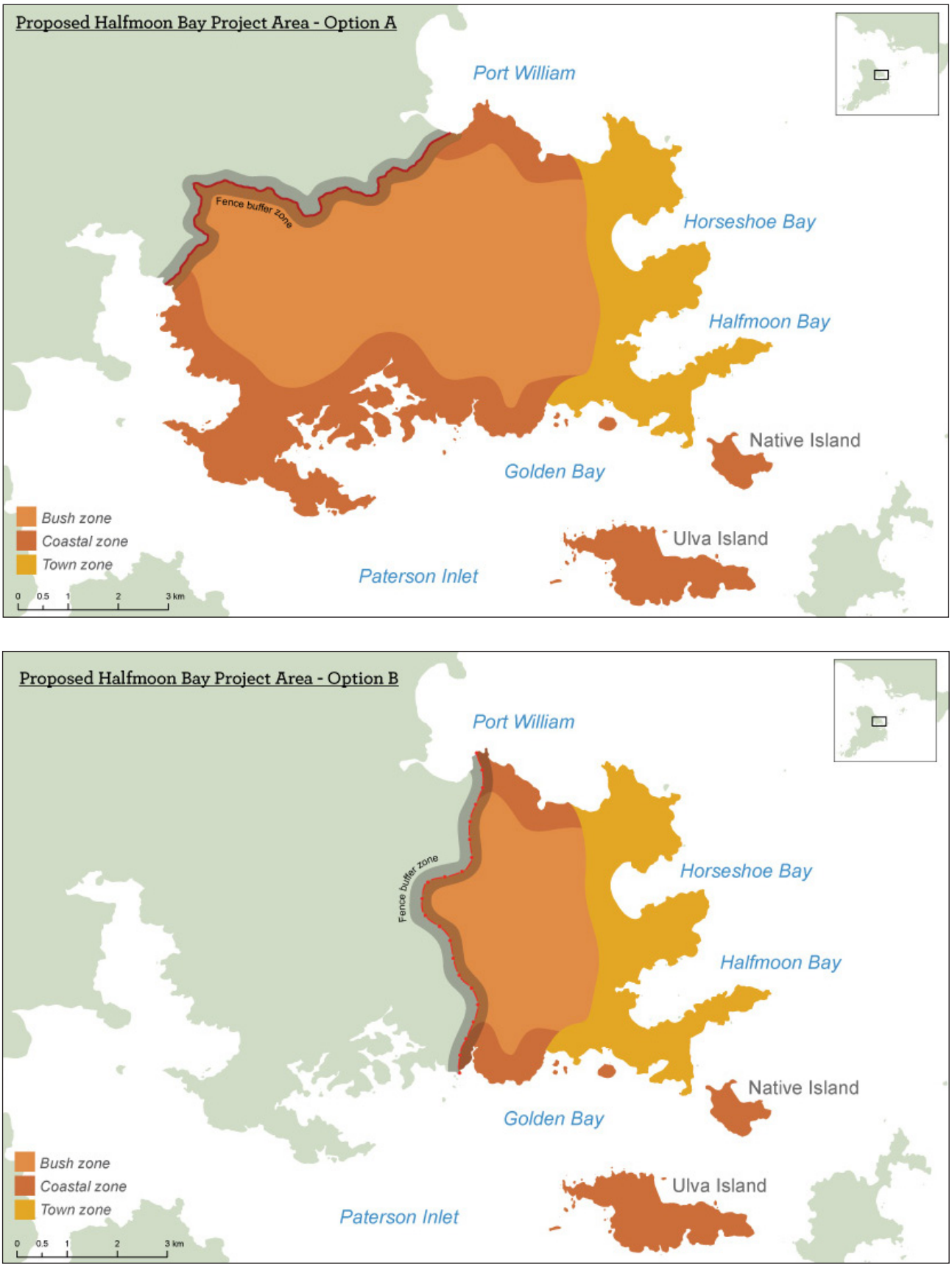

Figure 8. Halfmoon Bay Project area with location of proposed 'surveillance zones' for Options A and B.

- **Bush zone**—The Bush Zone constitutes all the remaining area within the HMB Project area (approximately 2540 ha for the 4800 ha project area and 500 ha for the 2150 ha Project Area). It is a low-risk zone for entry, but all of the target species would happily establish here and would still require low-level surveillance.

Within each zone, surveillance could be conducted using the recommended tools (as previously described) set up along well-marked and cut routes (Fig. 8). These routes would have already been established as part of the initial programme to remove predators [1]. It is recommended that the distance between surveillance lines be 100 m for Town, Coast and Fence zones, and 500 m for the Bush zone. Two smaller pockets of more intensive surveillance (lines at 50 m apart) would also be conducted within the last 500 m of the fence ends to allow for the increased likelihood of incursion there. Requirements within the quarantine zone would need to be set after an initial site inspection, as would any particularly high-risk areas identified during predator-free warrant surveys, (if undertaken).

Different arrangements of devices (arrays) should be considered, but as a starting point it is recommended that one surveillance device is placed at 25 m intervals in a sequence along a designated surveillance line (Fig. 9). Further expert consideration should also be given to stratifying the different devices according to whether or not they: kill/catch the target species and retain the body (i.e. traps); kill the animal without retaining the body (e.g. toxins); or detect animals (tracking tunnels, chew cards, trail cameras and passive surveillance). If the device arrays are stratified, devices that kill an animal and provide a body would be best placed at entry points where frequent inspection is possible. Devices that kill but do not provide a body would be more useful at high-risk sites where frequent inspection is more difficult. Devices that merely detect are likely to be better used in the low risk areas (J. Parkes pers. comm.).

Different surveillance devices could also be paired up (e.g. bait station with tracking tunnel; trap with chew card), or all placed close together at each station. Larger spacing between devices is not recommended because the number and size of 'holes' in the network through which an animal could pass undetected becomes too great.

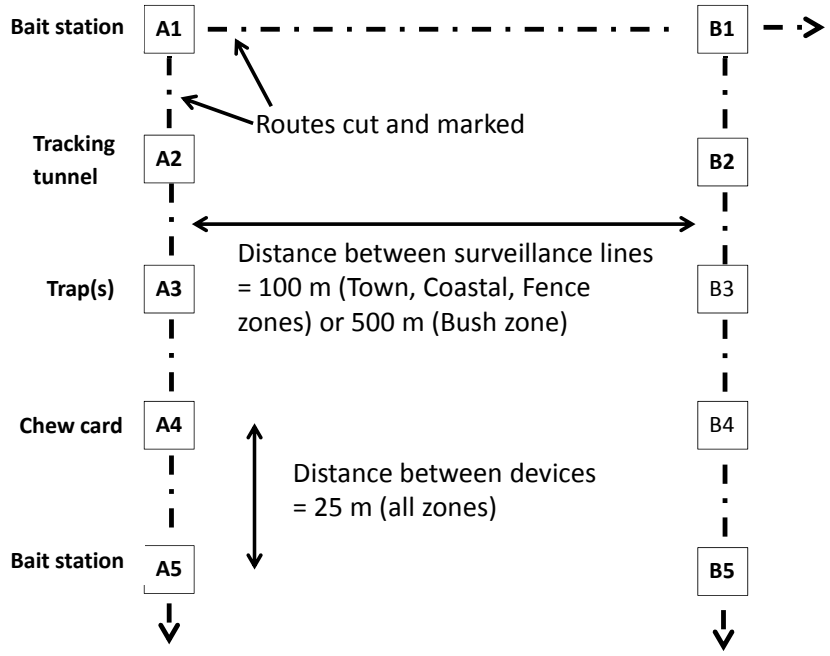

Figure 9. Suggested deployment and spacing of surveillance devices for the PFR Halfmoon Bay Project.

Project staff undertaking surveillance trips would be required to check and maintain gear (including the fence), and carefully record any evidence of predator capture or interference with the surveillance devices (e.g. traps sprung with no captures, exact quantities of bait taken). Tracking tunnel and chew cards would usually be collected and/or replaced after 3 days, but further details outlining this work would need to be developed as part of an operational monitoring plan, including specific notes on device placement and maintenance similar to DOC 'best practice' standards.

A suggested checking regime is included here based on the estimated level of risk associated with each zone (Table 3) and other biosecurity project guidelines (Appendix 1). The frequency of surveillance checks within each of the designated zones would also need to be responsive to the needs of the programme (e.g. increasing numbers of checks if surveillance data identified 'hot spots' of frequent incursion. It is recommended not to conduct device inspections during rodent- and/or other predator-detection dog surveillance because both activities would be compromised. The dog team require freedom to work off-track and to respond to any possible sign. It is also possible that a dog's presence at or near a device could reduce the likelihood of a target predator interacting with device because of scent left by the dog.

Table 3. Frequency of checks for surveillance grids in different zones

ZONE	PROJECT OPTION	APPROXIMATE AREA	INTERVAL BETWEEN DEVICE CHECKS	INTERVAL BETWEEN DETECTION DOG CHECKS	INTERVAL BETWEEN OTHER PREDATOR DETECTION DOGS
Quarantine and high-risk areas	4800 ha	10 ha	1 week	1 week	As required
	2150 ha				
Town	4800 ha	1200 ha*	4 weeks	8 weeks	Cats = 16 weeks, others as required
	2150 ha				
Fence	4800 ha	880 ha	2 weeks (inside only)	4 weeks (inside only)	8 weeks (inside only)
	2150 ha	700 ha			
Coast	4800 ha	1060 ha	4 weeks	8 weeks	16 weeks
	2150 ha	100 ha			
Bush	4800 ha	2540 ha	8 weeks	16 weeks	32 weeks
	2150 ha	100 ha			

* Estimate currently includes the Dancing Star reserve.

Trail cameras could also be paired up with a number of the devices, ensuring that there is equal coverage of the Project area and that enough data is available to test the effectiveness (or performance) of each device. The camera data could also be used to test different deployment arrays which may be used within the different surveillance zones. This requirement would mean at least ten cameras were needed per device type (n = 40), multiplied by the number of different deployment arrays. Extra trail cameras could also be set up at high risk sites or 'hot spots' as they are identified later in the programme.

Data from all surveillance devices should be regularly checked and audited to ensure consistency among different observers. It should also be analysed as a whole data set at least once each year (possibly twice, or even four times in the first year). This latter analysis may suggest changes to device placement and/or checking regimes and thereby increase efficiency and better deployment of resources.

A summary of the tasks required within each zone is available in Appendix 4.

What happens if predators reinvade?

Following the incursion of any predator inside the HMB Project area, the response should be managed using a simplified version of the NZ Coordinated Incident Management System (CIMS). This system has been developed in New Zealand for responding to civil defence emergencies, search and rescue operations, and other multi-agency emergencies [27]. It is primarily aimed at co-ordinating the actions of multiple groups and providing clear communication and leadership during response. The CIMS has become a standard practice for biosecurity incursions managed by NZ Government agencies including DOC. An example of a plan is presented in Fig. 10 and a similar plan would be required for the HMB Project once important decisions about leadership, resources and staff responsibilities were made.

In general, any sign of predators inside the HMB Project area would require project staff (with detection dogs) to rapidly respond within 24 hours (rats/mice) or 48 hours (other predators). A rapid response means a much lower chance of an incursion leading to the re-establishment of a population. In reality, many incursions will not result in population establishment because the invading predator(s) may not be able to survive and/or breed (individual males, non-pregnant females, or small groups). However, detection devices will not allow managers to quickly determine whether the invader is part of a population, so precautionary approaches would be required. The area of incursion would need to be delimited as soon as possible with immediate access to predator detection dogs and any other tools required for response. These tools would not necessarily differ from those used already in the project (detection dogs, traps and bait stations); however, the way they were used would need to be carefully planned and there would likely be a greater reliance on detection dogs during the early response phase. Different traps or toxins/baits might also be necessary if it was thought that target animals were avoiding those already in place.

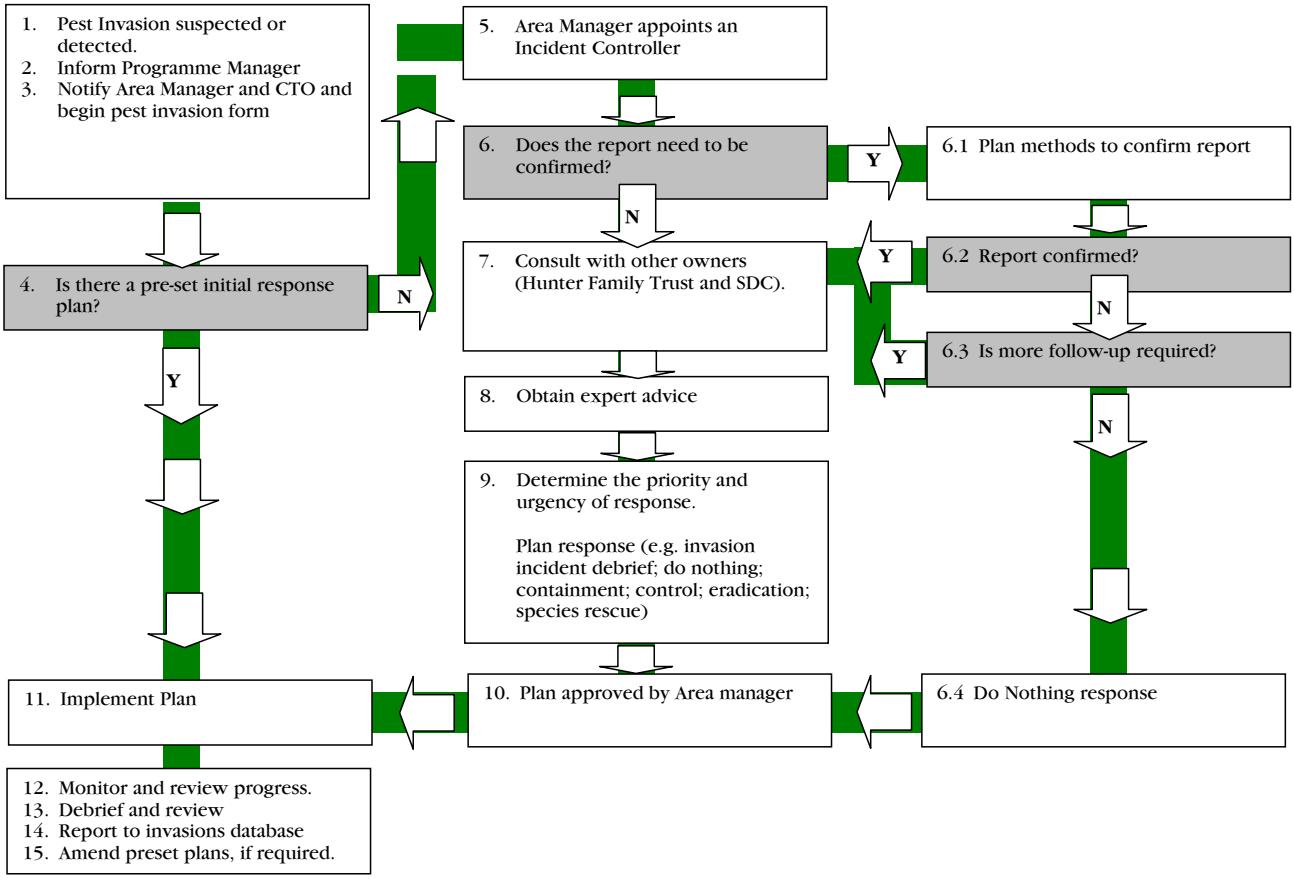

Figure 10. Screenshot of response plan taken from the Ulva Island Biosecurity Plan (updated 2014). NB A version of this would be developed specifically for PFR after decisions about staff structure has been made.

Following any response programme, a period of surveillance with no detections is suggested before declaring the project area 'predator free' again. The exact period of time and effort required should be informed by previous research into this topic [28] plus the rules that will need to be developed during and following the initial predator removal attempt [1].

What are the next steps?

If the project were to proceed past the concept phase, the next phase of biosecurity work would largely be in two areas—project management and research needs. These are listed below.

Project management

- Develop biosecurity-specific advocacy and communications as part of the overarching engagement work for Predator Free Rakiura.
- Undertake thorough cost/risk assessment of all proposed biosecurity activities, particularly regarding the establishment of quarantine and surveillance at departure and arrival points versus arrival points only.
- Resolve issues with domestic cats.
- Decide what biosecurity measures are to be undertaken and prepare a biosecurity plan.
- Refine budgets for all biosecurity tasks.
- Establish PFR biosecurity staff structure and develop role responsibilities.
- Develop CIMS response programme, including lead agency and likely costs.
- Develop process for delimitation surveys following detection of invaders.
- Decide whether the predator-dog programme should be in-house or contracted out [21] and develop a plan for a dog training programme on the island.
- Establish contact and collaboration with DOC predator dog programme to discuss sharing of resources accessing advice on training etc.
- If agreed to, further develop the individual property action plans and the Predator Free Warrant programme.
- Develop a strategy for data capture, storage, analysis and reporting.
- Develop a programme for auditing and testing the strength of systems at quarantine, surveillance and response stages.
- Develop timeframes and a workflow plan for various activities.

Research needs (some of these have a broader relevance than just the PFR Project)

- Conduct surveys of number of boat arrivals and pest presence inside quarantine areas.
- Conduct a survey of biosecurity programmes around NZ to determine the proportion of interceptions using dogs at wharves etc. (Note: ideally, this survey would include information from the Rakiura Tītī Islands' biosecurity programme.)
- Carry out a literature review and develop specific recommendations for how to maximise search efficiency and safely declare areas predator-free following removal, and/or reinvasion.
- Further develop the surveillance programme—device properties, arrays and checking regimes.
- Research and recommend appropriate traps/bait stations for commercial and recreational boats.
- Keep track of and consider new technological developments (e.g. automatic detection networks, improved attractiveness of devices to detect isolated individuals, long-life bait types etc.)

2.3.3 Concluding comments

In many ways, the proposed HMB project is both ambitious and very aspirational. A successful biosecurity system for a project of this size and complexity would be a substantial task to administer, and require strong, ongoing community support. If the project does proceed and predator removal is successful, most of the activities proposed in this document would eventually become a routine part of life on Rakiura. However, the cost of these to inconveniences to the Programme, individuals, and businesses would be greatly outweighed by the enormous biodiversity, cultural and economic benefits that would come from such a large and accessible eco-sanctuary.

3. Glossary

Biodiversity: The variation among living organisms. This includes diversity within and between individuals, species and ecosystems.

Biosecurity: Systems put in place to prevent pests from establishing somewhere they are not wanted. For the Halfmoon Bay Project, pests include possums, feral cats, hedgehogs, rats and mice.

CIMS: Coordinated Incident Management System, used for response.

Containment facility: An area where gear and luggage can be checked without a target predator being able to escape.

Frequency: How often an event occurs.

Governance Group: Representatives of the community who are responsible for overseeing decisions for Predator Free Rakiura and the Halfmoon Bay Project.

Halfmoon Bay Project (HMB): The proposal to remove possums, cats, hedgehogs and rats from approximately 4800 ha surrounding Halfmoon Bay, including the construction of a predator fence and managing a biosecurity system.

Incursion: Direct evidence (live or dead animals or unequivocal sign) of possums, feral cats, hedgehogs, rats, mice or mustelids (ferrets, stoats, weasels) into the HMB Project area. Incursions can be 'suspected' until proven.

Neophobic: Inheritable fear/avoidance of new things or objects.

Pathway: The potential path taken by a predator into the HMB Project area.

Predator detection dogs: Dogs trained as part of the official DOC programme to detect specific predators.

Predator Free Rakiura (PFR): The long-term vision to permanently remove all predators from Stewart Island/Rakiura.

Predator removal: In terms of the HMB Project, this means the complete removal of possums, feral cats, hedgehogs and rats from the project area.

Pressure: The density of target predator species at a source area and the number of pathways and vectors departing from the source area to the HMB Project area.

Quarantine: Activities that prevent predators from travelling into the Halfmoon Bay Project area.

Response: Activities to remove predators after an incursion.

Risk: The likelihood of occurrence of an incursion.

Surveillance: Activities that search for predator incursions.

Vector: The means by which a predator could travel into the HMB Project area.

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Appendix 1

Examples of pest eradication and elimination around New Zealand

SITE	TARGET PESTS (ANIMAL ONLY)	PROJECT DETAILS AND KEY BIOSECURITY LESSONS AND INNOVATIONS
Campbell Island/Motu Ihupuku	Norway rats and others	11330 ha; Very Isolated subantarctic island; unpopulated and restricted entry.
Kapiti Island	Cats, possums, Norway rats and kiore. Also cattle, sheep and goats.	1965 ha. Ungulates eradicated much earlier than possums, cats and rats. Stoats invaded more recently but were removed, costing at least $600k.
Taukihepa/Big South Cape Island	Ship rats	939 ha. Rats invaded 1960s, caused ecological devastation, and were eradicated in 2006. No known reinvasions since.
Rangitoto/Mototapu islands	Rats, mice, stoats, cats, rabbits, hedgehogs	3800 ha. Eradication by aerial bait drops of brodifacoum baits; 150,000 people visit per year including pressure from boat traffic. Biosecurity has been successful so far, partly by using 'Pest-free warrants'.
Tiritiri Matangi Island	Kiore	224 ha. Pest-free since mid-1990s. Island has similarities to Rakiura in proximity to urban areas and high visitation. Biosecurity has been successful so far, partly by using 'Pest-free warrants'.
Tawharanui Open Sanctuary	Many	590 ha incl. 2.5 km fence across peninsula. 160,000 visits per year. Fence cost = $625,000. Aerial toxic bait distribution for control. Ongoing and regular reinvasion by rats.
Maungatautari restoration project	Deer, Ppossums, goats, pigs, cats, hedgehogs, ferrets, stoats, weasels, Norway rats, ship rats	Mainland Island; approx. 3400 ha, 47 km fence, $20m cost (all activities up until 2011, not incl. volunteer labour). Mice, rabbits and hares still present. Mice appear to be entrenched.
Zealandia / Karori Sanctuary	Many	Mainland Island; 252 ha, 8.6 km fence > $10m initial cost for aerial poison operation. Mice still present. Weasels have also (re-)invaded.
Maud Island	Many	318 ha. Permanent DOC rangers. Mice re-invaded in 2013 and were not detected until 8 months after they had arrived. Stoats have also invaded many times in the past.
Ulva Island	Deer, rats	260 ha; Initially ground-based eradication completed 1996; frequent re-invasion of rats but no establishment until 2010/11, re-eradication required via aerial bait drop, cost in excess of $200k.
Dancing Star Ecological Preserve	Deer, cats, possums, rats?	160 ha. Cats and possums successfully removed by trapping, rats still present?
Bench Island	Rats	Aerial bait drop 2005, 121 ha
Pearl Island	Rats	Aerial bait drop, 2005, 512ha. Unsuccessful, rats reinvaded quickly from mainland. <200m between island and mainland.
Codfish Island / Whenua Hou	Possums, rats	1400 ha; Completed 2000; Aerial toxic bait drops; Strict biosecurity limits (i.e. permit needed to visit).

Appendix 2

Summary of surveillance and detection tools

(See text for full details on deployment)

SURVEILLANCE TOOL	TARGET SPECIES	COST	RELIABILITY FOR DETECTION	USEFULNESS FOR RESPONSE	RECOMMEND?	NOTES
Wax tags	Rats, mice, possums	Cheap	Reasonable	Reasonable	No	Exposed to weather if using bait; small surface area for detection, only available to one individual
Tracking tunnels	Rats, mice, possibly hedgehogs and mustelids	Cheap	Good	Good	Yes	Strong familiarity in small mammal pest monitoring (especially in DOC); can have interference problems and saturation of index if target species is numerous; need covers; surveillance only; small mammals only (rats, mice, small hedgehogs).
Chew cards	Possums, rats, mice, possibly hedgehogs, cats and mustelids	Very cheap	Very good	Very good	Yes	Multiple species detection device, including all target species. Able to detect multiple species at the same time on a single card; Very quick, easy coverage; Attraction to cats, hedgehogs and mustelids may be less than to rodents and possums;
Leg-hold traps	Possums	Expensive	Poor	Poor	No	Performance is poor because of the small proportion of 'escapes' which creates a high risk of trap-shy individuals. Human error is possible with setting. Need checking every 24 hours.
Snap traps	Rats, mice	Moderate	Reasonable	Reasonable	Yes	Require maintenance. Human error with setting is possible. Escapes are possible which creates a high risk of trap-shy individuals. Recommendation to include is for mice only.
DOC series predator traps	Rats, Hedgehogs	Expensive	Good	Good	Yes	Require maintenance and trap box.
Self-resetting traps	Possums, rats, mice, hedgehogs, cats	Very expensive	Poor	Poor	No	Poor performance is based on the first round of tests by DOC and anecdotal evidence. Improved versions of traps are becoming available, but as yet still untested.
Dogs	Possums, rats, mice, hedgehogs, cats	Very expensive	Good	Good	Yes	Essential in detection and response as a backup to other surveillance. Usually only single species detection; a limited pool of available dogs could mean a delayed response time. Some chance of dog or handler error.
Hair snags or scats for DNA sampling	All	Expensive	Poor	N/A	No	Surveillance and research only. Could help determine predator origin i.e. incursion or survivor
Camera traps	All	Very expensive	Unknown	N/A	Yes	Surveillance only
Shooting	Cats, possums	Very expensive	Poor	Poor	No	High chance of human error

Appendix 3

Property action plans and predator-free warrant system

Outline of predator-free warrant process for vessels operating in the HMB Project area

1. Identify vessel owner/operator and get them to agree to enter programme.
2. Outline responsibilities of programme and contact people.
3. Present vessel owner/operator with brief questionnaire (see below), which will be sent back when complete.
4. Biosecurity officer reviews questionnaire, coordinates a time to meet with owner/operator.
5. Biosecurity officer checks vessel with detection dog, and completes first inspection survey form (see below).
6. Biosecurity officer compiles brief report including any specific activities for vessel (e.g. bait station type and placement, food storage, mooring locations etc.). This is a vessel's biosecurity plan.
7. Vessel biosecurity plan presented to vessel owner/operator along with tools, if necessary.
8. Discussion and feedback.
9. Sign-off by both parties and agreement on schedule for checks.
10. Vessel revisited for second inspection, if necessary.
11. Regular re-testing every 3 months initially, reduced to every 6 months after 2 years of no onboard predator sign.

Predator-free warrant for vessels operating in the Halfmoon Bay Project area—questionnaire

For all commercial and recreational vessels operating in the Halfmoon Bay Project area, the following data will be collected by a biosecurity officer with the owner/operator's permission.

Contact and vessel details	
Vessel name	
Vessel owner/operator	
Vessel captain	
Main contact person	
Regular mooring(s)	
Vessel length	
Galley food stowage area pesent?	
Rubbish stowage area present?	
Rodent trap / bait stations on board?	
Are any traps / bait stations on board the vessel?	
What type of traps / bait stations and where are they located?	
How often are they checked?	
If vessel is mooring overnight inside HMB Project area, but away from HMB main wharf	
Where are these other moorings?	
Are there any traps or bait stations in place on land near the mooring?	
If yes, who is currently responsible for checking them?	
If vessel is mooring overnight outside the HMB Project area	
Where are these other moorings?	
Are there any traps or bait stations in place on land near the moorings?	
If yes, who is currently responsible for checking them?	
Reporting and recording	
Do you have a log book for keeping records (date of checks, any bait take and any rodents caught)?	
Do you understand the predator free project and the need to communicate any rodent (or other pest) sign?	
Packaging of supplies and rubbish:	
Are supplies on board the vessel packed in rodent-proof containers?	
Does the vessel ever carry supplies that can't be packed in rodent-proof containers?	
If yes, are additional quarantine measures available to check gear (e.g. at Bluff)?	
Does the vessel have secure and sealed container(s) available for rubbish disposal on board?	
Passengers	
Will the vessel be used for carrying tourists and/or non-local passengers?	
If yes, will passengers be briefed on biosecurity requirements?	
Notes	

Predator-free warrant for vessels operating in the Halfmoon Bay Project area—on board inspection

For all commercial and recreational vessels operating in the Halfmoon Bay Project area, the following data will be collected by a biosecurity officer and rodent detection dog, on board the vessel with the owner/operator..

Contact and vessel details	Comments including Pass/Fail/ Follow-up
Vessel name	
Vessel owner/operator	
Vessel captain	
Main contact person	
Regular mooring(s)	
Date vessel inspected	
Vessel inspected by	
Vessel length	
Galley food stowage area	
Rubbish stowage area	
Rodent trap / bait stations on board?	
How many traps / bait stations are suitable for the vessel's length and specifications?	
What type of traps / bait stations and where should they be located?	
How often should they be checked?	
If vessel is mooring overnight outside HMB Project area	
Discuss surveillance options and checking regime	
Reporting and recording	
Present with log book for keeping records (date of checks, any bait take and any rodents caught)	
Provide background to project and need to communicate any rodent (or other pest sign)	
Packaging of supplies and rubbish:	
Are supplies on board the vessel packed in rodent-proof containers?	
Does the vessel ever carry supplies that can't be packed in rodent-proof containers?	
If yes, are additional quarantine measures available to check gear (e.g. at Bluff)?	
Does the vessel have secure and sealed container(s) available for rubbish disposal on board	
Passengers	
Is the vessel used for carrying tourists and/or non-local passengers?	
If yes, are passengers briefed on biosecurity requirements?	
Detection dog	
Did the detection dog indicate anything?	
Next inspection due	
When is the next biosecurity check due?	
Notes	

Outline of property action plans for private and commercial properties inside the HMB Project area

1. Identify property owner/manager and get them to agree to enter programme
2. Outline responsibilities of programme and contact people
3. Present property owner/manager with brief questionnaire (see below), which will be sent back when complete.
4. Biosecurity officer reviews questionnaire and coordinates a time to meet with owner/manager.
5. Biosecurity officer checks property with detection dog and complete first inspection survey form (see below).
6. Biosecurity officer compiles brief report including specific activities for the property (e.g. bait station/trap type and placement, food storage containment areas, high risk structures and areas etc.)
7. Property biosecurity plan presented to property owner along with tools, if necessary
8. Discussion and feedback
9. Sign-off by both parties and agreement on schedule for checks.
10. Property re-visited for second inspection, if necessary.
11. Regular re-testing every 3 months initially, reduced to every 6 months after 2 years of no predator sign on the property.

Property Action Plan (Biosecurity) for properties in the Halfmoon Bay Project area—questionnaire

For all private, commercial and public properties in the Halfmoon Bay Project area, the following data will be collected by a biosecurity officer with the owner/operator's permission.

Contact and property details	
Owner's name	
Manager/occupier	
Main contact person	
Property address	
Contact address	
Property size	
Dwellings present?	
If yes, how many?	
Rubbish or food areas present?	
Rodent traps / bait stations on property?	
Are any traps / bait stations present on the property?	
What type of traps / bait stations and where are they located?	
How often are they checked?	
Reporting and recording:	
Do you have a log book for keeping records (date of checks, any bait take and any rodents caught)?	
Do you understand the predator free project and the need to communicate any rodent (or other pest) sign?	
Food, gardening and building supplies and rubbish	
Are any food, gardening or building supplies on the property or near by?	
Is there uncontained rubbish on the property or nearby?	
Coastal connection	
Is the property adjacent to the coastline?	
Are there any moorings on or near the property?	
Notes	

Property Action Plan (Biosecurity) for properties in the Halfmoon Bay Project area—on site inspection

For all private, commercial and public properties in the Halfmoon Bay Project area, the following data will be collected by a biosecurity officer with the owner/operator's permission.

Contact and property details	Comments including Pass/Fail/Follow-up
Owner's name	
Manager/occupier	
Main contact person	
Property address	
Contact address	
Date property inspected	
Property inspected by	
Dwellings present?	
If yes, how many?	
High-risk areas present?	
If yes, number and details	
Rodent traps / bait stations on property?	
How many traps / bait stations are suitable for the property size and specifications?	
What type of traps / bait stations and where should they be located?	
How often should they be checked?	
Reporting and recording	
Present with log book for keeping records (date of checks, any bait take and any rodents caught)	
Provide background to project and need to communicate any rodent (or other pest) sign	
Packaging of supplies and rubbish	
Are supplies on the property of concern for biosecurity?	
Does the property have rubbish?	
Does the property have secure and sealed container(s) available for rubbish disposal?	
Detection dog	
Did the rodent detection dog indicate anything?	
If yes, what follow-up action is required?	
Next inspection due	
When is the next biosecurity check due?	
Notes	
	Indicate Pass/Fail/Follow-up actions