# APPLICATION FOR RESOURCE CONSENT BY BROOK WAIMARAMA SANCTUARY TRUST FOR PEST ERADICATION FROM THE BROOK WAIMARAMA SANCTUARY

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# APPLICATION FOR RESOURCE CONSENT BY BROOK WAIMARAMA SANCTUARY TRUST FOR PEST ERADICATION FROM THE BROOK WAIMARAMA SANCTUARY

**Contract Report No. 3695**

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**Prepared for:**
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# EXECUTIVE SUMMARY

This Assessment of Environmental Effects (AEE) relates to the resource consent required from Nelson City Council for the aerial discharge of brodifacoum bait into the Brook Waimarama Sanctuary to eradicate pest mammals. Aerial application of brodifacoum is the primary means of achieving Brook Waimarama Sanctuary Trust's (BWST) objective of eradicating rodents and other mammalian pests from within the pest-proof fenced sanctuary.

Brodifacoum is an anticoagulant pesticide, which is contained in widely-used rodentcontrol products available for purchase at most New Zealand supermarkets. Brodifacoum is highly toxic to rodents and has been used successfully in eradication programmes on New Zealand's offshore islands up to the size of Campbell Island (11,200 ha) and within all the large fenced mainland sites: Maungatautari, Waikato (3,400 ha), Tawharanui Regional Park, Auckland (588 ha), Shakespear Regional Park, Auckland (500 ha), Orokonui Ecosanctuary, Dunedin (300 ha), Zealandia, Wellington (225 ha), Cape Sanctuary, Hawkes Bay (2,500 ha), Rotokare, Taranaki ( 230 ha), and Bushy Park, and Wanganui (100 ha). A total of approximately 25 tonnes of Pestoff Rodent Bait 20R (containing 20 parts per million (0.002%) ) is proposed to be discharged in winter 2016 at an average application rate of 36kg/ha delivered over three applications a minimum of two weeks apart.

Consultation with a wide range of parties has been undertaken since the inception of this project. Feedback received to date is generally favourable. Consultation with interested and affected parties will be ongoing throughout the resource consent application process, and throughout the implementation phase of the pest eradication. A summary of consultation carried out with key stakeholders is provided.

Information on the effects of the operation on non-target species and soil and water quality is presented, along with how any negative effects will be avoided, remedied or mitigated. The operation is expected to have significant ecosystem restoration benefits as well as protecting many species of threatened plants and fauna. Effects of the operation on human health are discussed and performance measures for minimising these risks have been set in place.

The statutory and regulatory requirements of the operation are set out and information is provided on how the operation will meet these requirements. The content of the AEE has been assessed against the statutory framework of the Resource Management Act 1991 and relevant regional planning documents.

This AEE has been prepared with consultation and expert advice and consideration of resource consent applications, decision reports, and post-operational reports for similar operations. The conclusion reached in the report is that the proposed operation will have significant positive effects on the environment, and that it will have no more than a minor adverse effect on the environment. Observed and documented ecological recovery following pest animal eradication operations leaves no doubt that the intended positive outcomes accruing from this activity are significant and desirable. The proposal has significant support from the public, stakeholders, and affected parties. No significant opposition to the proposal has been identified through the consultation process to date. The proposal is consistent with the objectives of the New Zealand Biodiversity Strategy, Nelson Biodiversity Strategy 2013, Nelson City Council - Conservation and Landscapes Reserve Management Plan 2009, and relevant provisions of regional plans.

The AEE has been prepared in conjunction with the requirements and performance standards detailed in the Code of Practice for Aerial and Hand Broadcast Application of Pestoff Rodent Bait 20R for the Intended Eradication of Rodents from Specified Areas of New Zealand and the relevant Department of Conservation Standard Operating Procedures, including the Brodifacoum Pesticide Information Review.

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# 1. INTRODUCTION

Brook Waimarama Sanctuary extends over 691 hectares of former Water Reserve owned by Nelson City Council. Most of the site comprises mature beech forest with occasional large podocarps. The southern part of the site comprises diverse broadleaved forest on land cleared in the 19th Century. Over 250 plant species have been recorded in the Sanctuary and the birdlife includes rare species such as New Zealand falcon (*Falco novaeseelandiae*), yellow-crowned parakeet (*Cyanoramphus auriceps*), western weka (*Gallirallus australis*), and robin (*Petroica australis*).

The Sanctuary project was launched in 2004 and has strong community involvement and support. The intention of the Sanctuary Trust is to undertake substantial ecological restoration. A 14 km predator exclusion fence is currently under construction (Appendix 1) and it is proposed to remove all introduced mammalian pests from within the fence. The predator-proof fence will prevent reinvasion of introduced mammalian pests into the Sanctuary from surrounding areas.

The site is an ideal size, being large enough to support diverse complements of indigenous plants and fauna, but small enough to be easily manageable. It is also in a very good location, being short distances from Nelson City, Stoke, and Richmond, with forested corridors to take birdlife from the Sanctuary into these areas and into residents' gardens. It is joined to the south to 100,000 plus hectares of indigenous beech forest extending into the Mt Richmond Forest Park.

An Assessment of Environmental Effects (AEE) is required as part of a resource consent application to Nelson City Council for aerial application of Brodifacoum to eradicate rats and mice from the sanctuary. Wildland Consultants Ltd, on behalf of the Brook Waimarama Sanctuary Trust, has prepared this AEE to:

- Describe the site and its environment.
- Consider the reasons for eradication of mammalian pests from the Brook Waimarama Sanctuary.
- Evaluate the strengths and weaknesses of the various options for eradicating mammalian pests.
- Describe the proposed operation.
- Assess the negative impacts of the proposed pest animal control operation on the environment.
- Assess the benefits of the proposed pest animal control operation.
- Outline appropriate management of the actual and potential adverse effects of the pest animal control operation.
- Propose a programme of monitoring.

# 2. SANCTUARY VISION

Long-Term Vision and Goals

The intention of the Brook Waimarama Sanctuary Trust is to undertake substantial ecological restoration within the Sanctuary. Their long-term vision for the Sanctuary includes the following goals:

- Restoration of forest fauna communities including the reintroduction of lost species such as kiwi (*Apteryx* sp.), South Island saddleback (*Philesturnus carunculatus*) and tuatara (*Sphenodon punctatus*).
- The site provides a resource to the community allowing community members to get involved in practical conservation on their doorstep.
- The Sanctuary provides a reservoir population for birds and other indigenous wildlife which will disperse through the Brook valley into Nelson City, and east into Mt Richmond Forest Park.
- The site is used by local schools and others as an educational resource for studying New Zealand flora and fauna.
- The Sanctuary becomes a significant tourist attraction.
- Māori history and values are recognised and exposure to them enriches those who visit and are involved in the restoration of the site.
- Nelson City residents treasure and protect increasing numbers of indigenous birds.
- The site provides job development and training opportunities in the following areas: education and advocacy, animal pest and weed control, restoration planting and propagation techniques, wildlife handling and breeding.
- Restoration initiated in The Brook eventually extends to the Marsden and Maitai valleys.

The Trust's vision complements the following:

The New Zealand Biodiversity Strategy

The New Zealand Biodiversity Strategy has been prepared in response to the state of decline of New Zealand's indigenous biodiversity. The purpose of the Strategy is to establish a strategic framework for action, to conserve and sustainably use and manage New Zealand's biodiversity.

- *Goal One: Community and individual action, responsibility and benefits.*

  Enhance community and individual understanding about biodiversity, and inform, motivate and support widespread and coordinate community action to conserve and sustainably use biodiversity.

Enable communities and individuals to equitably share responsibility for, and benefits from, conserving and sustainably using New Zealand's biodiversity, including the benefits from the use of indigenous genetic resources.

- *Goal Two: Treaty of Waitangi.*

  Actively protect Iwi and Hapu interests in indigenous biodiversity, and build and strengthen partnerships between government agencies and the Iwi and Hapu in conserving and sustainably using indigenous biodiversity.

- *Goal Three: Halt the decline of New Zealand's indigenous biodiversity.*

  Maintain and restore a full range of remaining natural habitats and ecosystems to a healthy functioning state, enhance critically scarce habitats, and sustain the more modified ecosystems in production and urban environments; and do what is necessary to maintain and restore viable populations of all indigenous species and subspecies across their natural range and maintain their genetic diversity.

Nelson Biodiversity Strategy 2013 Review

The purpose of the Nelson Biodiversity Strategy is to create a biologically rich and sustainable future for Nelson through aligned action on biodiversity. The Trust is a signatory to the strategy.

- *Goal 1: Active protection of native biodiversity.*
- *Goal 2: Ecologically sustainable use of biodiversity.*

Objectives under Goal 1 are that "ecological health, mauri and wairua of natural ecosystems are sustained" (Objective 1.1) and that "native biological diversity is restored, enhanced and, where appropriate, connected" (Objective 1.2). There are several references to the Brook Sanctuary, including Action #18 (terrestrial environment actions): "supporting the flagship Brook Waimarama Sanctuary restoration".

Nelson City Council - Conservation and Landscapes Reserve Management Plan 2009

The purpose of the management plan is to provide for the management of 14 Nelson City Council reserves. Goal 5.2 is of particular relevance to the Brook Waimarama Sanctuary.

*Goal 5.2: Biodiversity protection*

5.2.1: Protect areas of indigenous vegetation and habitats of indigenous fauna on reserves, especially those areas adjoining streams and rivers, and on or adjacent to mineral belt areas.

5.2.2 Enhance indigenous biodiversity values of reserves as part of reserve maintenance and development.

5.2.3 Restore, or encourage the restoration of, indigenous vegetation and habitats of indigenous fauna on reserves, where appropriate.

Section 6.3 of the strategy sets out specific policies for the Brook Conservation Reserve, including 6.3.1. "Provide for the long term lease, not exceeding 33 years, or equivalent mechanism, of the majority of the reserve (*c*.715 ha) to the Brook Waimarama Sanctuary Trust for the purpose of creating a pest-free sanctuary for the protection and restoration of indigenous vegetation and habitats. Also provide for a change to the Local Purpose status of the reserve (currently waterworks reserve) to be in line with this purpose (wildlife sanctuary)".

# 3. SITE DESCRIPTION

A site plan for the Brook Waimarama Sanctuary is provided in Appendix 1. The plan shows the area enclosed by the predator-proof fence, the helicopter landing and refuelling site for aerial application of a pest eradication toxin, and identifies all adjacent landowners. The site ranges in altitude from 90-873 m above sea level, with an average slope of 35º. It has several permanent watercourses that flow into the Brook Stream, and is within a five minute drive of the Nelson City centre, but is bounded in the east by over 100,000 ha of Mt Richmond Forest Park.

## 3.1 Indigenous vegetation and flora

In 2002 the vegetation of the site was described as part of a survey of Nelson City Council Reserves identifying five vegetation types and providing details information on these communities (North 2008).

In 2004 the Trust commissioned a detailed vegetation survey using recce plots which identified eight vegetation types (van Eyndhoven and Norton 2004):

- Red/silver beech forest
- Hard beech forest
- Black beech forest
- Podocarp/black beech forest
- Upper gully forest
- Lower gully forest
- Kanuka forest
- Gorse/broom scrub

The Sanctuary comprises a wide variety of forested habitat ranging from lowland broadleaved-angiosperm forest to montane beech forest. In addition there are substantial areas of regenerating forest. The integrity of the site was identified as most threatened by the browsing of goats. The effect of predators on indigenous fauna was described as likely to be highly significant as elsewhere in the country.

Red beech (*Fuscospora fusca*) is the co-dominant vegetation type over much of the Sanctuary, with silver beech (*Lophozonia menziesii*) co dominant at higher altitudes. Hard beech (*Fuscospora truncata*) occurs on drier sites and black beech (*Fuscospora solandri*) is uncommon. About one-third of the catchment is in a highly modified state including regenerating lowland beech/broadleaved species forest, kanuka (*Kunzea ericoides*) forest, and very limited exotic plantings. Scattered mature podocarps occur throughout the Sanctuary including kahikatea (*Dacrycarpus dacrydiodes*), rimu (*Dacrydium cupressinum*), matai (*Prumnopitys taxifolia*), miro (*Prumnopitys ferruginea*), and Hall's tōtara (*Podocarpus hallii*).

A list of vascular plants has been compiled, largely by members of the Nelson Botanical Society, and comprises over 250 species. This is a very high diversity of plants for a small area. The list includes four rare plants: two mistletoes (*Peraxilla tetrapetala*) and (*Ileostylus micranthus*), a filmy fern (*Hymenophyllum flexuosum*), and bamboo grass (*Microlaena polynoda*).

Other features are tawa (*Beilschmiedia tawa*) which is near its southern limit, tōtara (*Podocarpus totara*) which is an indicator of fertile alluvium, the fern *Asplenium lyallii* which is indicator of calcareous substrates (e.g. limestone), and four other ferns (*Hypolepis distans*, *Botrychium biforme*, *Cyathea cunninghamii and Lastreopsis velutina*) which are uncommon in Nelson/Marlborough (S. Courtney, Department of Conservation, pers. comm.).

No aquatic plant surveys have been carried out.

## 3.2 Indigenous fauna

The Trust has carried out bird counts in the Sanctuary since 2009. The following indigenous birds are common in the Sanctuary: tui (*Prosthemadera novaeseelandiae*), bellbird (*Anthornis melanura*), grey warbler (*Gerygone igata*), brown creeper (*Mohoua novaeseelandiae*), fantail (*Rhipidura fuliginosa*), and silvereye (*Zosterops lateralis*). Robin, kererū (*Hemiphaga novaeseelandiae*), tomtit (*Petroica macrocephala*) and morepork (*Ninox novaeseelandiae*) are present in relatively low numbers (BWST, unpublished data). Western weka are becoming more common in the Sanctuary. Yellow-crowned kakariki are heard regularly and three red-crowned kakariki (*Cyanoramphus novaezelandiae novaezelandiae*) and blue duck (*Hymenolaimus malacorhynchos*) have been seen. Red-crowned kakariki are classified as "At Risk-Relict" by Robertson *et al.* (2013). New Zealand falcon (*Falco novaeseelandiae*), rifleman (*Acanthisitta chloris*), New Zealand kingfisher (*Todiramphus sanctus vagans*), and welcome swallow (*Hirundo neoxena neoxena* are regularly recorded. Long-tailed cuckoo (*Eudynamys taitensis*) and shining cuckoo (*Chrysococcyx lucidus*) are summer visitors.

Reptile surveys undertaken in 2013 (Bryant 2013) found the following species in low or very low numbers within the Sanctuary: forest gecko (*Mokopirirakau granulatus*), Nelson green gecko (*Naultinus stellatus*), common gecko (*Woodworthia maculata*), and common skink (*Oligosoma polychroma*). Forest gecko and Nelson green gecko are classified as "At Risk-Declining" as per Hitchmough *et al.* (2012).

The invertebrate fauna of the Sanctuary is not well described. The area has been well collected by entomologists, particularly when the Department of Industrial and Scientific Research had a facility in Nelson, and is the type locality for several species. An entomologist from Exeter University (UK) collected some baseline data on invertebrate populations inside and outside the area of the proposed fence several years ago. The Trust organised pitfall trapping inside and outside in different habitat types in August-December 2014 and is repeating that in 2015. No report is currently available. Monitoring of Nelson's streams and rivers has found that a site in the upper reaches of The Brook within the proposed Sanctuary was one of the three best in the Nelson region in terms of its macroinvertebrate community, which was dominated by pollution-sensitive mayflies and caddisflies (Crowe 2002).

Fish records held by NIWA in the Freshwater Fish Database show that six indigenous fish species, including three species classified as "At Risk-Declining" by Goodman *et al.* (2014), have been recorded in the Brook Stream catchment (Table 1) and it is probable that most of these are present within the fenced area.

Table 1: Freshwater fish species recorded within the Brook Catchment.

| Common Name | Scientific Name | Threat Status as per Goodman *et al.* 2014 |
|---|---|---|
| Brown trout | *Salmo trutta* | Exotic |
| Longfin eel | *Anguilla dieffenbachii* | At Risk-Declining |
| Shortfin eel | *Anguilla australis* | Not Threatened |
| Banded kokopu | *Galaxias fasciatus* | Not Threatened |
| Upland bully | *Gobiomorphus breviceps* | Not Threatened |
| Inanga | *Galaxias maculatus* | At Risk-Declining |
| Koaro | *Galaxias brevipinnis* | At Risk-Declining |

## 3.3 Introduced birds

Introduced birds observed in the sanctuary include: blackbird (*Turdus merula*), song thrush (*Turdus philomelos*), chaffinch (*Fringilla coelebs*), greenfinch (*Carduelis chloris*), yellowhammer (*Emberiza citrinella*), goldfinch (*Carduelis carduelis*), and redpoll (*Carduelis flammea*).

## 3.4 Introduced mammals

The Brook Waimarama Sanctuary is inhabited by a wide range of introduced vertebrate pests including: rats (*Rattus rattus* and *R. norvegicus*), mice (*Mus musculus*), brushtail possums (*Trichosurus vulpecula*), rabbits *(Oryctolagus cuniculus)*, hares *(Lepus europaeus)*, stoats (*Mustela erminea*), weasels (*M. nivalis*), feral cats (*Felis catus*), hedgehogs (*Erinaceus europaeus*), red deer (*Cervus elaphus*), fallow deer (*Dama dama*), feral pigs (*Sus scrofa*), and feral goats (*Capra hircus*). All of these pest animals pose a significant threat to the indigenous fauna and plant values in the Sanctuary.

## 3.5 Historic sites

In the eastern part of the Brook catchment, the Dun Mountain Walkway follows the alignment of New Zealand's first railway built in 1860. Except at Four Corners, the proposed perimeter track and fence will be sited at least 50 m downhill of the walkway, so as not to affect its historic values.

There is a cluster of archaeological sites within the site, in the bed of The Brook upstream of the existing big dam wall. They comprise structures and pipe work associated with Nelson's early water supply system. Nelson City Council has applied for a resource consent to retain these structures.

# 4. OVERVIEW OF THE PROPOSED OPERATION

## 4.1 Description

Brook Waimarama Trust proposes to undertake a pest control operation within the fenced Sanctuary (described in Section 1) to eradicate all introduced mammalian pest species.

It is proposed to eradicate rodents (rats and mice) using the aerial application of baits containing Brodifacoum, with the application to be supplemented by the hand-laying of baits to ensure operational success.

To achieve a successful eradication (as opposed to control) the following criteria must be met:

- All individuals (i.e. 100% of the population) must be exposed to and susceptible to the chosen method(s).
- Pests must be killed faster than they can breed.
- The risk of reinvasion must be manageable

The following are essential criteria for the eradication method chosen:

- It must cause minimal disturbance to the natural environment.
- The method must be cost effective.
- Adverse effects on other wildlife must be outweighed by benefits to the natural ecosystem as a whole.
- Any risks to human health can be avoided, remedied or mitigated.
- Any risks to farm stock can be avoided, remedied or mitigated.

<u>Eradication</u>

Eradication of pests is the only viable option to meet the vision and objectives of the Sanctuary as it will create the prerequisite conditions for restoration of the natural processes and subsequent protection of reintroduced indigenous species. An eradication programme would also mean that any adverse effects associated with the introduction of toxins into the environment are largely one-off and confined to a short time interval. The one-off nature of an eradication depends on the implementation (and long-term maintenance) of pest animal biosecurity and surveillance measures designed to minimise the risk of rodent reinvasion of the Sanctuary. A monitoring and mop-up plan is being developed to ensure early detection and removal of rodents remaining within the area after initial aerial pesticide applications and as a response to reinvasion.

Aerial application of cereal pellets containing brodifacoum is the only legally registered and cost-effective method proven and capable of eradicating rodents from fenced mainland sites and offshore islands of similar size, topography, and vegetation. Bait must be laid in all areas as successful eradication of rodents relies on all animals being exposed to bait. The technique has now been applied very successfully at a number of New Zealand's foremost wildlife sanctuaries, including mainland fenced sanctuaries and offshore islands with minimal long-term impacts to non-target species.

Derived from many years and multiple previous operations, the Department of Conservation's recommended best practice for eradication of rodents from islands (Broome *et al.* 2014), which is also applicable to fenced "mainland islands", states that only three options should be considered, and these are all various methods of distributing anticoagulant toxins. No other methods are recommended. Lack of experience with other methods would have significantly higher risks, both for operational failure and in unforeseen non-target effects. The Department of Conservation's Best Practice documents for rodent eradication states:

"*The most common method in New Zealand to eradicate rodents has been the aerial application of rodent baits containing the second generation anticoagulant toxin brodifacoum, the focus of this best practice. If aerial application is not feasible then investigate hand broadcasting brodifacoum baits. If this is not feasible then consider applying brodifacoum baits in bait stations. If brodifacoum cannot be used, consider cereal baits containing the first generation anticoagulant diphacinone as a higher risk alternative*."

## 4.2 Timing

The operation will encompass three separate applications of bait, and it is proposed that it take place within the period of 1 June 2016 to 30 September 2017. All three bait applications must occur within one season. Successful application of bait is weather-dependent, with operational success likely to be compromised by inclement weather.

Winter is the chosen operational period because this is when rodents will be at lowest densities due to a lack of breeding, and because they are also more stressed and in poorer condition due to colder weather and a scarcity of food. Winter is also usually the wettest period of the year, so any bait that is not consumed should breakdown more rapidly than if the operation was to be undertaken at other times of the year.

The operation would only proceed if the long-range forecast from the MetService (and other sources) indicate a forecast of less than 15 knots and four fine days (three fine nights) without significant rainfall (less than 6 mm) for each day when aerial application would occur.

## 4.3 Bait storage and application

The bait recommended for this operation is Pestoff Rodent Bait 20R. Each bait weighs approximately 2 grams, and has a toxic loading of 20 ppm or 0.02 g/kg Brodifacoum.

Brodifacoum is an anticoagulant, which is contained in widely-used rodent control products available for purchase at most New Zealand supermarkets. The chemical formula is $C_{31}H_{23}BrO_3$ and the official chemical name is 3-[3-[4-(4-Bromophenyl) phenyl]-1,2,3,4-tetrahydronaphthalen-1-yl]-2-hydroxychromen-4-one. Brodifacoum, works by inhibiting vitamin-K dependent blood clotting factors in the liver, leading to death from internal haemorrhaging. Consequently vitamin-K1 is an effective antidote to Brodifacoum poisoning.

In New Zealand, Brodifacoum is used principally to control brushtail possums and rats, but Pestoff 20R is only registered for rodents. Brodifacoum is highly toxic to rats and mice and has been used successfully in rodent eradication programmes on New Zealand's offshore islands up to the size of Campbell Island (11,200 ha) and within all the large fenced mainland sites: Maungatautari (3,400 ha, Waikato), Tawharanui (588 ha), and Shakespear Regional Parks (*c.*500 ha) (Auckland), Orokonui (300 ha, Otago), Zealandia (225 ha, Wellington), Cape Sanctuary (2,500 ha, Hawkes Bay), Rotokare (230 ha, Taranaki), and Bushy Park (100 ha, Wanganui). Some additional information on Brodifacoum is provided in Appendix 2 (and a comprehensive summary is provided in Broome *et al.* 2015).

A total of approximately 24 tonnes of bait will be applied aerially within the Sanctuary over three drops resulting in an average application rate of approximately 31 kg/ha over the whole sanctuary. Bait will be applied in three separate applications, a minimum of two weeks apart. The rates are specified in Table 2 below.

Table 2: Targeted bait application rates for the first, second, and third bait drops, including a 10% contingency.

| Application No. | Rate (kg/ha) | Area (ha) | Total Bait (kg) | +10% | Total |
|---|---|---|---|---|---|
| 1 | 15 | 691 | 10,365 | 1,036 | 11,401 |
| 2 | 8 | 691 | 5,528 | 552 | 6,080 |
| 3 | 8 | 691 | 5,528 | 552 | 6,080 |
| **Total** | **31** | **691** | **21,421** | **2,140** | **23,561** |

The application rate exceeds that used during other eradication programmes targeting rodents for several reasons. Most significantly because the presence of possums, goats, deer, pigs, rabbits and hares in the sanctuary, which consume bait reducing the amount available for rodents. The bait application rate of approximately 15 kg/ha for the first bait application with approximately 8 kg/ha for the second and third applications, is typical of other eradications where large numbers of non-target pest species capable of consuming bait have been present..

Bait applications would be no less than two weeks apart, with bait sown from 1-2 helicopters using GPS equipment to follow predetermined flight paths. The helicopters would use spreader buckets designed specifically for the application of bait. To ensure comprehensive coverage of the operational area, bait would be applied along parallel flight lines approximately 35 m apart. Flight lines would be spaced to give a 50% overlap in adjacent bait spread swaths. To avoid bait going over the fence, bait would not be dropped within a 5-10 m buffer on the inside of the fence. This will be achieved through the use of a directional bucket (a bucket fitted with a deflector to send baits inwards) to sow baits close to the buffer. Section 2.7.1(c) Code of Practice for Aerial and Hand broadcast of Pestoff Rodent Bait requires that; All treatment areas within 25 metres of the boundary fence will be treated with boundary buckets that have a certified swathe width of less than 10 metres. The boundary strip around the fence line will be treated using a trickle bucket for one or two swaths, depending on the suitability of the area (ie where it can be safely done with risk of bait going outside the fence). One trickle bucket swath will be targeted around the debris line inside the fence line to ensure sufficient bait in this area.

To ensure there is sufficient bait to complete hand sowing of the buffer between the aerially sown area and the fence, the bait order will allow for a strip of 20m around the 14.5 km boundary. This gives a total of approximately 29ha of land that will need to be hand sown around the boundary. At an application rate of 31 kg/ha, this requires a total of approximately 900 kg. However hand sowing frequently uses more bait than planned, due to the tendency to apply more. As such, a contingency of 20% is also included in our calculation. This results in a total of approximately 1,080 kg of bait to be hand sown. Hand sowing will be undertaken by Brook Waimarama Sanctuary staff and volunteers.

While there are variations in both the slope and the vegetation types across the sanctuary, none are deemed significant enough when compared with the unknown number of non-target bait consumers to warrant attempting to use variable baiting rates as this significantly complicates the operation. It is believed that possum numbers are densest in the secondary forest however this area has been subject to targeted ground trapping to reduce numbers.

25 Tonnes of bait will be ordered and applied during the operation. This covers all aerial and ground applications.

The rationale for the three separate bait applications is:

- To ensure complete coverage of the Sanctuary.
- To minimise the risk of rain washing out the bait.
- To compensate for potential bait competition between ungulates, possums, and rodents i.e. if rodents in certain locations are unable to access baits during the first application because baits within their home range are consumed by pigs or goats, then they will have the opportunity to feed on bait during the second or third application.
- To allow for the possibility that mice are in high abundance within the regenerating forest in the northwestern part of the Sanctuary, i.e. repeat applications will be required to kill all of them.

Application of the bait within the Sanctuary would comply with the New Zealand Food Safety Authority's Code of Practice, which is available at: http://www.pestoff.co.nz/pdf/Code%20of%20Practice%2020R.pdf. The Code of Practice provides guidance on bait clean-up and spillage. Sections 1.10 and 2.2 referring to Pest Proof Fencing are of particular relevance.

Detailed consideration has been given to transportation and storage of the bait, which is to be packaged in 25kg paper walled bags with polythene-coated liners. These have been chosen as they keep the bait in good condition, while still providing packaging that will withstand a moderate impact before breaking.

Bait will be stacked on pallets, with a maximum total weight of 1,050 kg, with each pallet to also be shrink-wrapped before leaving the Animal Control Products factory. Pallets will be transported at single height only, and securely tied to prevent any movement in transit. Drivers will be experienced and briefed on the nature of the goods.

Bait will be stored in a purpose-built and fully-approved secure and lockable shed, inaccessible to the public at Campbell Farm, Blenheim. This facility is used extensively by TBfree and the Department of Conservation for operations undertaken throughout the Nelson and Marlborough Regions.

On the days of each of the three aerial applications the specified volume of bait to be used on that day will be moved from the storage shed to the loading site. All activity will be in accordance with the requirements and performance standards of the Code of Practice for Aerial and Hand Broadcast Application of Pestoff Rodent Bait 20R for the Intended Eradication of Rodents from Specified Areas of New Zealand.

Hand-broadcasting of bait will be undertaken by trained personnel and locations of areas where this is undertaken will be recorded on operational maps each time this technique is used.

## 4.4 Outcomes and targets

The project is a community-based initiative with the goal is to create a pest-free wildlife Sanctuary close to the Nelson City centre. Integral to creating the Brook Waimarama Sanctuary is construction of a pest-proof fence 14 km long, to enclose the area, and to eradicate all pest mammals within it. This will enable the re-creation of a historic piece of New Zealand which today is only found on a few offshore islands. Resident birds, reptiles and invertebrates would flourish and species previously lost from the area could be reintroduced.

The Trust's pest control targets are the complete eradication of rats, mice, mustelids, possums, feral cats, hedgehogs, deer, goats, and pigs from within the fenced area. While the aerial Brodifacoum operation would specifically target rodents and possums, it is likely to reduce the abundance of the other pest species through non-target poisoning (e.g. feral goats, pigs, deer) or secondary poisoning (e.g. mustelids and feral cats that scavenge on rodent carcasses).

## 4.5 Rodent mop-up and eradication of other pest species

The Brook Waimarama Trust is already undertaking substantial predator control within the Sanctuary. Mustelid (stoats and weasels), hedgehogs, and rats are currently controlled by intensive trapping in about one-fifth of the area, with traps spaced at approximately 50 m intervals on lines 100 m apart. Possums are also being trapped by the Trust, and a hunter is targeting pigs, deer, and feral goats in the Sanctuary.

The aerial application of Brodifacoum has proven to be an extremely effective method of eradicating populations of multiple mammal species from islands (e.g. Griffiths *et al.* 2015) and it is likely that most stoats, weasels, feral cats, possums, hedgehogs, pigs, goats, and deer will die following non-target or secondary poisoning from the aerial Brodifacoum. However, following the aerial application of Brodifacoum there will be some residual populations of some species and there may also be residual populations of rodents. Intensive monitoring using the established trap network and passive detection devices (e.g. ink footprint tracking-tunnels) would be used to detect these residual populations.

It is intended that the predator-exclusion fence will prevent reinvasion of stoats, weasels, hedgehogs, rodents and feral cats within the Sanctuary and any survivors will be eradicated through ongoing ground control.

It is acknowledged that there is potential for pest animal incursions by various pathways including:

- Breaches of the predator-proof fence and associated infrastructure (culverts, swales, gates).
- Movement of materials and personnel associated with operational activities.

Experiences at other predator-proof fenced sites provide an understanding of this incursion risk, but also the confidence that such incursions can be detected and removed before significant adverse biological consequence occurs. It also gives the site managers confidence that regionally- and nationally-significant conservation outcomes are achievable from this model of conservation management despite occasional pest incursion.

A pest animal monitoring (surveillance) network will be established throughout the entire the Sanctuary, with an emphasis on swiftly locating any pest incursions and implementing remedial actions. Ground-based techniques will be used that are permitted activities. Biosecurity protocols will be compiled and implemented.

## 4.6 Past experience and successes

Worldwide, Brodifacoum baiting has been used in an estimated 71% of campaigns to eradicate introduced rodents from islands (Howald *et al.* 2007). Notable examples in New Zealand include Little Barrier (Hauturu), Tiritiri Matangi, Campbell, Browns (Motukorea), Rangitoto, and Motutapu Islands. The Rangitoto-Motutapu operation is particularly relevant, as it involved a similar suite of invasive mammals to those present in the Brook Waimarama Sanctuary and these were eradicated using three aerial Brodifacoum drops (Griffiths *et al.* 2015). Aerial Brodifacoum has also been used to successfully eradicate rodents and stoats from within several predator-proof fenced sanctuaries on mainland New Zealand. Examples include: Orokonui Sanctuary (Dunedin), Zealandia Sanctuary (Wellington), Maungatautari Ecological Island (Waikato), Shakespear Open Sanctuary (Auckland), and Kaipupu Point Mainland Island (Marlborough Sounds). All of these islands and mainland sites are now important wildlife refuges, and conduits for public advocacy and education in conservation.

On the basis of scientific evidence, and previous extensive experience with mainland predator-proof fenced areas and island rodent eradications, the aerial spreading of cereal pellets containing brodifacoum (Pestoff® 20R) is the only method that can be expected to have a high probability of achieving eradication of rodents and substantial proportion of other pest species. It also achieves the objective of the operation at a realistic cost, and with no more than minor impacts on the natural environment and with minimal risk to humans. Other options are not practically feasible, are cost prohibitive, and also carry a very high chance of failure.

# 5. POTENTIAL BENEFITS TO ECOSYSTEMS

## 5.1 Overview

Introduced mammal species have been eradicated from many islands and mainland fenced sites worldwide and, in every case, the eradication campaign has led to the long-term recovery of indigenous plant and fauna populations and ecosystems. In some cases, pest mammal eradication has made the difference between continued survival and extinction of threatened species. Removal of introduced mammal species from within the fenced area at the Brook Waimarama Sanctuary is likely to show similar benefits and, once eradication is confirmed, allow the reintroduction of threatened species that are currently absent.

## 5.2 Ecosystem processes

Introduced mammals have many effects on ecosystem processes that are difficult to detect or monitor. Research on subantarctic islands has shown that predation of invertebrates by mice affects soil cycling process and disrupts nutrient flow through the ecosystem. Rodents also limit forest regeneration through seed predation and can alter forest composition by selectively predating seed from some species. Damage to riparian vegetation or stream banks caused by feral ungulates can lead to increased sediment loads further downstream or damage fish and aquatic invertebrate populations by altering the in-stream environment to the point that it becomes unsuitable for some species to inhabit. These processes are hard to monitor but removing pest mammals will result in improvements in these processes which will have flow-on effects through the whole forest ecosystem.

## 5.3 Vegetation and flora

Possums, feral goats, feral pigs, and deer are well known for their selective foraging in New Zealand's forests (Wardle *et al.* 2001). In extreme cases, this can alter forest plant species composition, lead to canopy collapse following wind-throw, and retard forest regeneration (deer have reduced the density of the saplings of canopy species by 70-80% in some sites). Introduced mammals can also destroy flowers or remove key pollinators thus preventing any chance of plants reproducing. When rats were removed from Breaksea Island in Fiordland, seedling numbers increased dramatically (Allen *et al.* 1994), indicating that rats were suppressing forest regeneration on that island. A recent study focusing on a shrub that is almost exclusively pollinated by birds found that seed set on the mainland where pollinating birds were reduced or absent was 84% lower than it was in mammal-free sanctuaries where pollinating birds are abundant (Anderson *et al.* 2011). Mistletoes are also reliant for bird species for both pollination and seed dispersal and may increase in distribution and abundance once mammals are removed. An example of how mammal eradication can increase nectar production is available from Rangitoto Island. Beehives in the pohutukawa

(*Metrosideros excelsa*) forest on Rangitoto showed an increase in annual honey production from a low of 7-8 kg a hive to over 80 kg in a hive following the successful eradication of possums and wallabies from the two connected islands (Mowbray 2002).

Significant changes in understory condition in the Brook Waimarama Sanctuary have already been observed through the reduction in goat numbers by shooting and it is expected that the health of the forest within the Brook Waimarama Sanctuary will improve further in the absence of all introduced mammals. Initially this response will be slower than that of fauna released from predation, but will also be assisted by restoration and planting efforts.

There is no evidence that brodifacoum will affect plants. The extremely low solubility of the toxin means it is very unlikely to be taken up by plants. Rodents are known to have a significant effect on indigenous plants (Towns *et al.* 2006, Campbell 2002, 2009), being known to eat seeds and young seedlings or foliage of many plants, inhibiting regeneration. The effect of rodents on vegetation may be subtle and not easily noticed at first appearance, but many species are reduced in health or struggle to reproduce through rodent consumption of their seeds, flowers, or seedlings. The structure and composition of the natural vegetation is changed as a result of these effects.

Following rat removal on the Chetwode Islands, Marlborough Sounds, surveyed seedling plots revealed a 20-fold increase in seedling numbers and a 7-fold increase in species diversity (Brown, 1997), strongly indicating the inhibitive effect rodents have on regeneration of certain plant species. Similarly, Ambrose (2002) noted major increases in seedling establishment of nikau and a *Hebe* species following rat eradication on Raoul Island.

## 5.4 Birds

Rodents, mustelids, feral cats, hedgehogs and brushtail possums are known to have significant adverse effects on the abundance, distribution, and viability of New Zealand's bird populations. Predation by stoats and feral cats is responsible for the annual mortality of over 50% of juvenile kiwi in unmanaged areas (McLennan *et al.* 1996), and stoats are a substantial threat to other forest birds, e.g. kākā (Wilson *et al.* 1998). Rats are now recognised as a major threat to endemic forest passerines (Innes *et al.* in press). Removal of introduced mammal species will result in improved survival and breeding success of many indigenous bird species through a reduction in predation pressure and competition for resources. Invertebrate populations are likely to bounce back quickly once predation pressure from rats and mice is removed and insectivorous birds such as grey warbler, fantail, tomtit, and brown creeper will benefit from an increase in their food supply. Morepork feed on mice, so removing mice from the Sanctuary may lead to a temporary food shortage for morepork until large invertebrate populations such as weta increase in numbers. Possums will often eat flowers that nectar-eating birds such as tui and bellbird rely on; such competition for nectar will be removed. In addition to increased breeding and survival of species currently present, bird species that are too vulnerable to exist in the presence of predators (e.g. kiwi or saddleback) will be able to be translocated to the Brook Waimarama Sanctuary.

## 5.5 Reptiles

Reptiles have been found in the diet of stoats, feral cats, and weasels with many species imperilled by this predation (Reardon *et al.* 2012). Mice and rats are also known to prey on lizards. Predator control often leads to dramatic increases in reptiles. For instance, implementation of large scale predator control in Hawke's Bay saw reptile tracking rates (in tracking tunnels) increase from 0% to 50% over a period of three years (A. Glen upubl. data). In a fenced Sanctuary with complete eradication of predators, such increases would be expected to be greater. There are also endemic reptiles such as tuatara that are unable to survive in the presence of even low densities of introduced predators. Eradication of pests from the Brook Waimarama Sanctuary will mean such species can translocated there, assisting with the long-term survival of these species, and providing a great visitor attraction for Nelson.

## 5.6 Invertebrates

Weta abundance has been negatively correlated with mice (Wilson and Lee 2010) and stoats are also known to eat large numbers of weta (Smith *et al.* 2005, 2008). Hedgehogs are insectivores and the full extent of their impacts on indigenous invertebrates is not properly understood (Brian Patrick, Wildland Consultants, pers. comm.). Studies at Maungatautari showed a dramatic increase in weta numbers following the pest eradication there (Watts *et al.* 2011) and a similar increase in numbers of weta, beetles, and large spiders was observed on Tiritiri Matangi Island following kiore (*Rattus exulans*) eradication (Green 2002).

# 6. EFFECTS OF BRODIFACOUM USE

## 6.1 Soil, water, and air quality

### 6.1.1 Overview

A significant public concern around aerial poison operations is the possibility of toxin accumulating in soil or water. This issue has been the focus of a large body of research over the years and the conclusion is that the concerns are unfounded.

The bait pellets that will be used in this operation are designed to be highly palatable to rodents and are made of cereal and sugar with a small quantity of wax and binders to allow the pellets to be formed. No preservatives are added to the pellets and uneaten bait pellets break down quickly following absorption of soil moisture or after rain. Baits placed underneath cages at Tawharanui Regional Park were monitored for several months and the baits had completely disintegrated after 110 days in all habitat types (Craddock 2003). Several studies have monitored Brodifacoum levels in soil directly underneath bait pellets as the pellets decay. Brodifacoum is insoluble in water and binds strongly to soil particles (Fisher *et al.* 2011). It is then broken down by microbial decay over a period of three to six months. Soil samples taken from underneath baits on Hauturu following an aerial Brodifacoum operation in 2004 had residues of 0.2-0.9 mg/kg on Day 56 and 0.03-0.07 mg/kg on Day 153. Soil samples taken at Tawharanui had residues at or below the minimum threshold for detection (0.02 µg/g) after 110 days. Other studies have detected no Brodifacoum residues in soils following eradication. It is very unlikely that this operation will lead to any build-up of Brodifacoum in the environment.

Brodifacoum is highly insoluble in water and it is very unlikely that Brodifacoum will be found in water following an aerial Brodifacoum application (Fisher *et al.* 2011). No Brodifacoum was detected in water samples taken after aerial operations on Red Mercury Island, Little Barrier Island, Rangitoto Island and Motutapu Island (Fisher *et al.* 2011). Water quality was monitored extensively following an eradication operation at Maungatautari. No Brodifacoum was detected in 217 samples collected from four streams, or in two samples collected from the fence boundary and 800 m downstream over a three month period (Fisher *et al.* 2011). Any Brodifacoum that may enter the water column quickly binds to organic matter in the sediment with very minimal impact on water quality (Eason and Wickstrom 2001). Once Brodifacoum is in the sediment it slowly breaks down as it does in soil. It is very unlikely that any Brodifacoum will be detected in any water samples following this operation.

Specific effects on air, soil and water quality are described in more detail in the following sections.

### 6.1.2 Air

The proposal will not result in any more than minor, localised adverse effects on air quality.

There will be temporary visible discharges of bait from helicopters onto the land/water below and there may be some localised emissions of dust and particulates associated with the loading of bait into the helicopter spreader buckets. However, these effects will be internalised within the bait application area and will not affect the air quality of the Region or affect the Region's ability to achieve air quality and amenity targets.

The proposal includes the aerial discharge of cereal-based brodifacoum bait from a helicopter. Bait release will be controlled via an underslung distribution bucket directly controlled by helicopter pilot. Positioning and spread will be aided and recorded by Differential Global Positioning System (DGPS). The baits will be small and solid, with only a very small volume of associated dust released as part of each bucket dispersal. The bait application will be undertaken on three separate days, each approximately two weeks apart (dependent on amenable weather conditions for the discharge of bait), rather than being an ongoing aerial discharge. It is anticipated that the vast majority of bait will reach land within the operational area in the same solid state it left the helicopter bucket, rather than become particulate matter and affecting air quality.

### 6.1.3 Soil

Cereal baits to be used in this operation are designed to break down following absorption of soil moisture, or after rain. Baits will break down by swelling, cracking, then crumbling, depending on the temperature and humidity. Mould and fungi can appear rapidly as breakdown proceeds. Once this has happened baits are less likely to be eaten by non-target species.

Although the cereal component of the bait disappears quickly, the toxin takes longer to breakdown. Brodifacoum is insoluble in water, and binds strongly to soil particles, where it is slowly broken down by soil micro-organisms to its base components, $CO_2$ and water, over a period of 3-6 months (Shirer 1992).

When baits disintegrate, brodifacoum remains in the soil where it will be slowly degraded by soil micro-organisms. Leaching from soil into water is therefore unlikely to occur, and only the erosion of soil itself would see any brodifacoum reaching water, and even then brodifacoum would remain absorbed in organic material and settle out in the sediment. In studies conducted by ICI less than 2% of brodifacoum added to soil leached more than 2 cm in a study where four soil types were tested (World Health Organisation (WHO) 1995).

Brodifacoum is strongly bound to soil particles, and radio-labelled brodifacoum was found to be effectively immobile (i.e. not leached) in four soil types (WHO 1995).

Craddock (2004) reported that where soil residues were found below disintegrating Pestoff® 20R pellets at Tawharanui Regional Park, Auckland, the residues remained below the Method Detection Limit (<MDL, in this case 0.02µg/g or 0.02 parts per billion)) from 110 days after the pellets were placed on the ground.

ICI suggests that the half-life in soil varies from 12-25 weeks depending on the soil type and temperature. Analysis of soil samples from Red Mercury Island and Coppermine Island following rat eradication using brodifacoum showed no brodifacoum in any samples, including samples taken only one month after the operation (Morgan 1993). However, microbial degradation is dependent on climatic factors such as temperature, and the presence of species which are able to degrade brodifacoum.

After 153 days the highest residue level measured from soil extracted from directly underneath Pestoff® 20R baits used on Little Barrier Island in 2004 was 0.07 mg/kg (R. Griffiths DOC internal report).

### 6.1.4 Fresh water

Where baits are dropped directly into freshwater, localised short-term contamination may occur, but the toxin will bind to organic matter in the sediment with negligible effects on water quality.

Brodifacoum is most unlikely to be detected in water after aerial application of baits as it is not mobile in soil and is extremely insoluble in water (<10 mg/l of water at pH 7).

Residues of brodifacoum have only once been detected in freshwater bodies following eradication operations in New Zealand. Brodifacoum could not be detected in water samples taken after aerial application of brodifacoum even directly downstream from baits lying in stream beds on Red Mercury, Lady Alice and Little Barrier islands (Morgan and Wright 1995, Ogilvie *et al.* 1997, Griffiths 2004). Similarly, samples tested from bore water on Little Barrier Island and at Tawharanui did not detect any brodifacoum.

The only residues of brodifacoum that have been detected in water bodies following pest control operations in New Zealand comes from a single sample of stream water collected 24 hours after bait application, and within 20cm of baits in the stream bed. This sample measured 0.083ppm and was one of 12 samples taken within one week of aerial application of 10 mm Pestoff 20R baits containing 20ppm brodifacoum to the Ipipiri Islands in the Bay of Islands in June 2009. Three of the four stream water samples taken within 24 hours of bait application had no measurable residues (MDL 0.02ppb) (Vestena & Walker 2010).

Samples of drinking water were taken from rainwater tanks on the Ipipiri Islands in the Bay of Islands following aerial application of 10 mm Pestoff 20R baits containing 20ppm brodifacoum in June 2009. A total of 25 samples were subsequently taken from 13 tanks and one bore over a two month period. No brodifacoum residues were found (MDL 0.02ppb) (Vestena & Walker 2010).

Extensive water sampling results from four streams, forwarded to Environment Waikato following Pestoff® Rodent Bait 20R application on Maungatautari in September and October 2004 at 15 kilograms per hectare and eight kilograms per hectare respectively, showed no trace of brodifacoum in stream water at pH 5.9 where sampling occurred: one hour, two hours, three hours, six hours, nine hours, 12 hours, 24 hours, 48 hours, 72 hours, two weeks, three months and following the first significant rain event, after bait application (Broome *et al.* 2012).

An accidental release of 700kg of brodifacoum bait occurred in a 30ha freshwater lake in Fiordland, and this was monitored for a month. No residual brodifacoum was detected in samples of lake water (Fisher *et al.* 2012).

## 6.2 Effects on non-target fauna

### 6.2.1 Overview

In an operation such as this, some mortality of non-target indigenous species is unavoidable. However, increased breeding success and survival of remaining individuals will compensate for any non-target losses within a few years of the operation. Most of the indigenous fauna species present within the Brook Waimarama Sanctuary are highly unlikely to eat Brodifacoum baits and are also unlikely to be affected by secondary poisoning. Potential effects on specific fauna groups are considered below.

### 6.2.2 Birds

While some individual birds may be affected by the use of brodifacoum baits, no native or non-native bird species present in the operational area is considered to be at risk at the population level from the proposed operation.

Loss of some individuals of a variety species is expected. However, any mortality of non-target species in the short-term will be far outweighed by reduced predation of eggs, chick or adults, with resultant better survival of populations in the longer term.

Secondary poisoning of predatory or scavenging birds from eating dead or dying rodents is possible, but is likely to impact on only a very small number of species. Species considered most vulnerable at this site include morepork and harrier, individuals of which have been found dead as a result of brodifacoum poisoning in previous operations.

Secondary poisoning of insectivorous species as a result of the operation is possible but considered unlikely based on past experience with this method. Laboratory studies show that brodifacoum is quickly eliminated from invertebrates through metabolism and/or excretion (Morgan *et al.* 1996). Correspondingly, the concentration of brodifacoum found in invertebrates collected after pesticide operations has been low, indicating that very large numbers of contaminated invertebrates would need to be consumed in a relatively short period to cause mortality (Morgan and Wright 1995). No invertebrates tested following the Stanley Island operation were found to have traces of brodifacoum (Towns *et al.* 1993). The chances of secondary poisoning are further reduced by the operation being carried out in winter when fewer invertebrate species are active (C. Green, Department of Conservation, pers. comm.).

Morepork

Of the bird species known to be present at Brook Waimarama Sanctuary, those most at risk from Brodifacoum poisoning are morepork and western weka. Morepork are known to feed on mice and morepork deaths have been recorded following eradication operations using Brodifacoum (Eason *et al.* 2002, Stephenson *et al.* 1999), most likely as a result of secondary poisoning. It is believed that morepork are only present in low numbers within the Sanctuary and if individuals are killed during the eradication campaign the species can be expected to recolonise the area within a short space of time. Morepork have remained abundant on Hauturu following bait application in 2004, suggesting that any mortality of individual birds did not have a population-level effect (Fisher *et al.* 2011).

In a few instances appreciable percentages of the morepork population have been affected in brodifacoum operations, e.g. three of 14 (21%) monitored morepork were killed on Mokoia Island (Stephenson *et al.* 1999), but in no instance has this been detrimental to these species' long-term populations (Stephenson *et al.* 1999). Morepork numbers did not significantly change on Kapiti (Empson and Miskelly, 1999), Stanley Island (Towns *et al.* 1993), or Red Mercury (Robertson *et al.* 1993) but did decrease on Tiritiri Matangi Island (C.R. Veitch, pers. comm. in Eason *et al.* 2002). Because mortality of morepork is likely as a result of eating rodents that have ingested bait, mortality would be expected regardless of the method used for toxin delivery, i.e. aerial or ground-based.

Weka

Weka are particularly susceptible to brodifacoum as their opportunistic scavenging behaviour means that they are highly likely to consume carcasses of animals that have been killed by Brodifacoum and they may also ingest baits directly. Some populations of weka have been eradicated from islands following pest mammal eradication operations and others have suffered 80-90% mortality. A similar outcome is to be expected at Brook Waimarama Sanctuary. It is proposed to capture some weka within the Sanctuary prior to the operation and release them outside it at a site to be agreed with the Department of Conservation. The population in the Sanctuary is expected to bounce back unaided - weka can produce several broods a year - but there would be the option to reintroduce birds from the current high populations in the region should weka be eliminated.

Western weka are present throughout much of the Nelson Region, and although native, are often regarded as a problem species due to their predatory behaviour. They can have major effect on ground-nesting birds by killing chicks or consuming eggs, and are a known predator of lizards and large invertebrates.

Ducks

Paradise shelduck is another species for which there could be high mortality. However, the Sanctuary population is very low (perhaps only one or two pairs, if any, due to limited habitat).

Dowding *et al.* (1999) reported a 60% mortality of paradise shelduck on Motuihe Island after aerial baiting.

Despite numerous paradise shelducks being found dead and significant declines in numbers at two of three monitoring sites following the Pestoff® 20R aerial drop at Tawharanui Regional Park Open Sanctuary, the overall numbers of paradise shelducks increased. Lovegrove and Richie (2005) attributed this to immigration from areas outside the Park.

In 2009 on Motutapu Island, 350 paradise shelduck were found dead, representing most of the resident population. However within one year the population had returned to close to pre-poison levels (Griffiths & Brown 2011).

Other generalist feeding ducks such as mallard would also experience appreciable mortality, as evidenced from the Motutapu Island project in 2009, where 72 mallard were found dead.

As with paradise shelduck, the population of other duck species, including mallard, within the Sanctuary is very low.

Other Bird Species

Unless mentioned specifically above, other species, such as fantail, silvereye, grey warbler, and kererū , do not appear to have been affected in any significant (adverse) way during previous pest eradications using brodifacoum.

This operation is likely to result in some mortality of non-target and non-native wildlife. Some of the common non-native birds, such as blackbird, sparrow, and chaffinch, present may therefore die as a result of the operation. However, these effects are not expected to be significant at a local population level and populations are expected to quickly recover.

Positive Effects on Birds

Previous eradication operations such as the eradication of kiore from Codfish, Putauhinu, and Rarotoka (McClelland 2002), Korapuki (Towns 1991), Motupao

(Parrish and Pierce 1993), and Tiritiri Matangi islands (Graham and Veitch 2001), and kiore and Norway rats from Kapiti (Miskelly and Robertson 2001) and Raoul (Ambrose 2002) have all demonstrated the overwhelming benefits of rodent eradication and the net positive effect for non-target species.

While some individual birds may be affected by the bait, the overall effect of the operation and its consequences will be beneficial to most populations.

Terrestrial bird species are likely to benefit substantially from the eradication of rodents. Many common native species present within the sanctuary area, such as the grey warbler, bellbird, tui, kereru, and fantail are expected to benefit through reduced predation and/or food competition from rodents and possums.

While some native species may benefit from a reduction in direct predation, many other species will also benefit from the associated reduction in competition following pest eradication. Recovery of the invertebrate fauna following pest eradication is expected to be significant (see discussion on invertebrates below) and this will have flow on effects for insectivorous bird species. Changes to the invertebrate fauna will also potentially improve the habitat for native species which may be transferred in future.

Similarly, herbivorous, fruit and seed eating species such as kererū are expected to have some benefit, and are expected to respond positively following rodent eradication as more natural food resources become available to them.

### 6.2.3 Reptiles

No negative effects on reptiles - tuatara, geckos, or skinks - have been reported as a result of rodent eradication operations on islands in New Zealand. While it is possible that some minor effects may occur, all reptile populations monitored on New Zealand islands have thrived positively following the removal of rodents, e.g. Towns 1991, C. Veitch pers. comm., Newman 1993, Towns and Stephens 1997, Brown 1997, Parrish and Pierce 1993. As examples, two months after brodifacoum bait was applied aerially on Stanley Island, lizard pitfall capture rates were 29% higher than the previous best (Towns *et al.* 1993), while Brown (1997) reported that the spotted skink (*Oligosoma lineoocellatum*) population on Nukuwaiata Island increased by 67% over the two years following the aerial application of brodifacoum bait.

It is well-documented that rats have a significant predatory effect on many of New Zealand's reptile species (Towns *et al.* 2006). The effect of mice is less clear. However available evidence suggests they can have a significant effect (Newman 1994) through predation and competition for food. Lizards would be particularly vulnerable to predation in winter months when they become dormant in low temperatures, making them easy targets for mice, which are small enough to access their refuge sites.

Eradication of rodents would allow the recovery of native species within the sanctuary, and would also enable subsequent reintroduction of threatened reptile species.

### 6.2.4 Invertebrates

Invertebrate species are not at risk from brodifacoum poisoning as invertebrates have a different blood clotting system to vertebrates (Shirer 1992). A number of recent studies in New Zealand have confirmed this to be the case (Eason and Spurr 1995; Morgan *et al.* 1996; Spurr 1996).

There is strong evidence that a variety of invertebrates are adversely affected by rodents. Larger species such as ground beetles, weta, and large-bodied native weevils are highly vulnerable. Long term studies undertaken on invertebrates on the Mercury Islands and Tiritiri Matangi Island have shown that large-bodied, nocturnal, flightless invertebrates have increased in population density following eradication of the small Pacific rat or kiore (C. Green, Department of Conservation, pers. comm.). The large native *Powelliphanta* land snail present on Blumine Island was not adversely affected when brodifacoum was used to eradicate mice. Previous island rodent eradications have shown that many invertebrate species, particularly the larger and flightless varieties will benefit.

### 6.2.5 Freshwater species

The low solubility of Brodifacoum in water (see above) makes it unlikely that any Brodifacoum will be present in water after aerial application of Brodifacoum baits. Freshwater fish species that may be present - galaxids, bullies, and eels - are unlikely to eat any baits that land in the water and are therefore unlikely to be affected by primary brodifacoum poisoning. Hypothetically, eels may be susceptible to secondary poisoning if they are able to scavenge carcasses of animals killed by brodifacoum, but this is considered highly unlikely, since eels are less active during winter when the operation is to occur.. Native fish (galaxids and eels) have survived similar rodent eradication operations on Red Mercury Island, Rangitoto/Motutapu, Zealandia Sanctuary and other locations with no known ill effect. There has been no reported mortality of native fish (Broome *et al.* 2012).

Toxicity for native fish species is unknown. The LC50 (Lethal Concentration 50%, the calculated concentration of a liquid that kills 50% of the test organisms) of brodifacoum to rainbow trout (*Oncorhynchus mykiss*) is 0.051 mg/l. Given that brodifacoum is not soluble in water, the main risk factor is direct consumption of bait. Feeding galaxids and bullies act on movement cues to catch prey, therefore stationary baits are unlikely to attract any interest.

The effects on any freshwater fish and other freshwater life are expected to be of minor and temporary nature only.

## 6.3 Ecosystem processes

On the basis of numerous previous rodent eradication campaigns on islands and at other fenced mainland sanctuaries, any short-term adverse effects are far outweighed by longer-term positive responses. Pest animal species presence within the operational area has led to significant adverse impacts on the habitat values and quality of the plant and animal communities. The proposed operation is likely to have significant restorative and long-term beneficial effects for the health of the indigenous ecosystem.

Rodents eat seed, seedlings, rhizomes, bulbs, fruit and flowers of a number of indigenous plant species (Campbell *et al.* 1984). With the removal of these impacts following the eradication there will undoubtedly be significant positive changes in the regeneration patterns of a number of plant species.

The increase (return of) invertebrate abundance should have many beneficial flow-on effects throughout the ecosystem. Invertebrates are close to the base of the food chain and thus insectivorous species such as birds, frogs, skinks, reptiles and invertebrates should all benefit from higher numbers of prey species following the eradication of pest species.

Consequently, no significant adverse impacts are anticipated for the ecosystem within the fenced Sanctuary. Any negative effect of the proposed operation on the ecosystems within the sanctuary is anticipated to be of a minor and temporary nature only.

## 6.4 Effects on non-target domestic animals

Domestic animals, including dogs, cats, and livestock, are susceptible to Brodifacoum poisoning, both through primary poisoning (direct consumption of baits) and secondary poisoning (consumption of an animal that has died from Brodifacoum poisoning). No dogs, cats or other domestic animals are permitted within the Sanctuary and therefore no domestic animals should be at risk of poisoning within the reserve.

As a precaution, paddocks adjacent to the operational area should be destocked prior to the first application of Brodifacoum baits. Neighbouring landowners will be given at least 48 hours' notice to allow time for stock to be removed. It is very unlikely that any baits will be spread outside of the operational area due to the use of differential GPS systems for navigation, highly experienced pilots, and the use of a hand laid buffer. However, if there was an accidental overfly, Trust staff would as far as possible remove the bait, and the New Zealand Food Safety Authority would be consulted. Further information on the exclusion of stock in areas surrounding a Brodifacoum aerial operation is available in Section 2.8 of the Code of Practice for the application of Pestoff® Rodent Bait 20R.

Screens will be installed on the downstream fence-crossing culverts on the Brook Stream, for the purposes of ensuring that baits and animal carcasses do not leave the operational area. Screens will be checked regularly. All baits and carcasses will be removed by Brook Sanctuary Trust staff and volunteers and disposed of within the operational area. Screens will remain in place until after the first significant rainfall event. These screens will limit the likelihood of carcasses, that could be scavenged by domestic animals, leaving the operational area.

## 6.5 Effects on human health

There is unlikely to be any risk to human health associated with this operation. People directly involved in the operation will follow a detailed safety plan that will ensure their safety, and members of the public will be excluded from the operational area until it is deemed safe for them to enter. Each 2 g bait contains such a small amount of Brodifacoum that a 15 kg child would have to consume over 90 baits and a 90 kg adult would have to consume over 550 baits to have a 50% chance of death from Brodifacoum poisoning. If any baits are accidentally ingested there is plenty of time to administer the antidote (Vitamin K) as Brodifacoum is slow acting. The table below provides more information on toxicity to humans.

Information on bait consumption levels required for poisoning is presented in the table below (based on Table 19 sourced from Broome *et al.* 2012). Calculations use the lowest reported oral LD50 in eutherian (placental) mammals of 0.25 mg/kg (range is 0.25 to 33mh/kg), and are therefore a precautionary extreme.

Table 4: Amount of Brodifacoum bait needed to be ingested by a human to result in death, based on the **$LD_{50}$**

| | $LD_{50}$ (mg/kg) | Average Weight (kg) | Amount (gms)* of 0.02 g/kg Brodifacoum Bait for $LD_{50}$ | Amount (gms)* of 0.05 g/kg Brodifacoum Bait for $LD_{50}$ |
|---|---|---|---|---|
| Child | 0.25 | 15 | 187.5 | 75 |
| Adolescent | 0.25 | 30 | 375 | 150 |
| Small adult | 0.25 | 60 | 750 | 300 |
| Large adult | 0.25 | 90 | 1,125 | 450 |

* These figures represent the amount of bait that would have to be consumed in one sitting for a 50% chance of death and are reproduced from Broome *et al.* (2015). This is a straightforward acute toxicity calculation without any 'safety factors' that are used to extrapolate the results of animal studies to humans.

Despite extensive use of brodifacoum over the last four decades within New Zealand for rodent control and eradication, there have been no incidents recorded of accidental poisoning of humans.

The recent Rangitoto/Motutapu aerial brodifacoum application occurred on islands with a number of resident staff, and with very high public visitation. These islands were closed only on the days when the applications occurred, and re-opened the following days. No instances were recorded of any adverse effect on any of the many thousands of visitors over the following weeks.

Given the presence of the fence, access to the Sanctuary can be strictly controlled. The appropriate level and duration of restriction on public access, based on monitoring of bait decay and other factors, will be established in collaboration with the Medical Officer of Health. The Sanctuary will be reopened to the public as soon as it is deemed safe to do so. Public warning signs will be put in place before, during and after the application of aerial brodifacoum, warning sign details are provided in section 11.

It is very unlikely that bait will be present on the ground and visible to the public. Uneaten bait will remain on the ground until it decomposes through micro-organism activity. Monitoring completed at Tawharanui, Little Barrier Island, and on Rangitoto and Motutapu islands showed it may take anything between a few days and up to (in extreme cases) four months for complete bait break down to occur in most habitats. However, in certain areas such as pasture, baits can completely disappear very quickly (often within a few days) due to slugs and snails feeding on them, as shown on Motutapu (D. Brown, pers. obs.).

Brodifacoum can be absorbed through the skin, but at levels far below (<200 times) those for doses administered orally (DOC 1997). The most likely means by which brodifacoum could enter a human system is through inhalation of fine particles by operational staff while handling open bags of bait. This will, to all extents practicable, be eliminated through complying with the legislation and performance standards in the 'Code of Practice for Aerial and Hand Broadcast of Pestoff Bait 20R for the Intended Eradication of Rodents from Specified Areas of New Zealand' and the Department of Conservation's 'Safe Handling of Pesticides Standard Operating Procedure', which details the personal protective equipment - including appropriate face masks - that are to be used when handling baits.

People involved in the operation will follow a detailed safety plan under the supervision of a dedicated safety officer. The safety plan will take account of all hazards identified for the operation and comply fully with the Code of Practice and the Safe Handling of Pesticides Standard Operating Procedure.

The antidote for brodifacoum poisoning is Vitamin K. Although brodifacoum is slow acting, and plenty of time is available for treatment of symptoms, sources of the antidote will be confirmed prior to the operation in order that it can be administered quickly. If any person ingests bait, medical advice and aid will be sought immediately.

The likelihood of any brodifacoum reaching the ground water supply as a result of the operation is virtually non-existent. No precautionary measures for protecting the ground water supplies are considered necessary.

## 6.6 Cultural and spiritual values

Tangata Whenua have expressed no significant concerns via their direct representatives on the Trust's Board. Like many other members of the community they see significant benefits from the proposed operation, including the restoration of taonga species to Nelson..

## 6.7 Effects on the local community

Most effects on the local community will be short-term. Noise from helicopters may provide a nuisance, but this will only be on the days that Brodifacoum is applied. The Sanctuary will be closed to the general public from the time of first bait application until baits are no longer visible (Section 10.2). In addition, the lower Dun Mountain trail and Coleman Link track will be closed during each day of the operation. Deer, feral goats, and feral pigs outside the Sanctuary should not be exposed to aerial Brodifacoum and therefore will still be available for hunting.

### 6.8 Management of risk and/or levels of exposure

Using Brodifacoum in a single operation to eradicate pest mammals rather than over an extended period to control pests means that the environmental impacts of the operation are greatly reduced. Brodifacoum can persist in the liver of sub-lethally poisoned animals and extended use of the toxin can increase the possibility of persistence of Brodifacoum in the environment (Fisher 2010). The proposed aerial operation will result in Brodifacoum being in the environment for a finite amount of time before being removed. The definition of success for the eradication is the removal of all introduced mammals from the Sanctuary. If any animals ingest a sub-lethal dose of Brodifacoum and survive they will be removed using an alternative control method so there will be no chance for Brodifacoum to persist in the livers of these animals. Brodifacoum residues in soils will break down rapidly and it is insoluble in water.

Adoption of operational best practice will reduce the potential risk for those non-target species considered susceptible. Techniques developed in recent years are important components of this operation. For instance dull green dyed bait (to be used in this operation) has been shown to be the least attractive to birds. Timing of the operation to coincide with the most inactive period for many non-target species will also serve to minimise the risks to non-target species, such as reptiles. The insoluble nature of Brodifacoum in water means it is unlikely to affect freshwater fauna and plants.

### 6.9 Conclusion

The proposal will have significant positive conservation outcomes and these will outweigh any adverse effects to the environment which will be short-term because the operation is a one-off. As identified above, research indicates that impacts on non-target species will be minimal, but that the long-term benefit of pest removal for these species will overwhelming enhance long-term population growth. Brodifacoum will not be present in the water and will break down in the soil within a few months.

## 7. OTHER OPTIONS FOR PEST CONTROL

A successful eradication requires that three criteria are met:

- Immigration of pest mammals into the fenced Sanctuary must be zero.
- All target animals must be put at risk by the eradication technique.
- Target animals must be killed at a rate exceeding their rate of increase at all densities.

These criteria are listed in the order that they must be considered. There is no point attempting to eradicate a species from an area if that species can recolonise from outside the area once the operation is complete. If immigration can be prevented the next step is to choose an eradication method that will ensure every individual of every target species can be killed. Time required to eradicate the target species using the chosen method must then be considered to ensure that all animals are removed before they have a chance to breed and replace individuals that have been removed.

Alternatives to the proposed eradication method of an aerial application of Brodifacoum are considered below and assessed against their ability to meet the eradication criteria. Once completed, the pest-proof fence will prevent immigration of pest mammals into the Sanctuary, meaning that the eradication methods are assessed according to Criteria 2 and 3.

## 7.1 Do nothing

The option of doing nothing is not acceptable because of its incompatibility with the long-term restoration objectives for Brook Waimarama Sanctuary.

## 7.2 Trapping

Some island populations of stoats have been eradicated using trapping and it is probable that mustelids could be eradicated from the Sanctuary once the fence is complete using trapping alone. Trapping may also work as the sole control method for feral cats. Possum numbers can be sustained at very low densities using trapping alone, but there is no evidence of possum populations being eradicated from an area using just trapping. To our knowledge, rodents have never been eradicated from an island or fenced Sanctuary using trapping, and the very high number of traps required to target mice in a 691 ha area is unfeasible and has a high risk of failure.

## 7.3 Ground-based poisoning

A network of ground-based bait stations containing para-aminopropiophenone (PAPP) could potentially eradicate mustelids and cats from the Sanctuary, although to the best of our knowledge this method has not been trialled before. Intensive poisoning using cyanide may successfully eradicate possums and this method has been used to reduce possums to zero-density in large forest blocks as part of ongoing management of bovine TB vectors.

Ground-based poisoning is highly unlikely to successfully eradicate rodents from Brook Waimarama Sanctuary. Rats have been eradicated from islands up to 100 ha using bait station networks at 25 to 100 m spacings. However, rat suppression has proven more difficult over larger areas. As with trapping, a grid of bait stations every 25 m would be required to eradicate mice and even this density of bait stations has a high probability of failure. Trials in the Rotoiti Nature Recovery Project showed that a 20 m × 20 m grid of bait stations would theoretically be needed to control mice in a non-beech-mast year. This would not achieve eradication and be ineffective during the years of heavy beech seeding. Mice can have home ranges as small as 0.5 ha (Ruscoe and Murphy 2005) meaning the chance of missing mice with bait stations is high. The aerial sowing rates proposed here will ensure all rats and mice are at risk, and this method has been proven to work elsewhere.

## 7.4 Alternative toxins

The only other toxin registered for aerial application for rodent and possum control is 1080. It is effective at killing rodents, possums, and other mammals, but because it is an acute (fast acting) toxin, there is a high risk of bait shyness if an animal does not consume a lethal dose. Animals that ingest a sub-lethal dose are likely to avoid eating baits in future and therefore survive the eradication attempt. 1080 is used widely as a control tool to reduce mammal population densities, but it has never been used to successfully eradicate a mammal population from an island or predator-proof fenced area. Mice have been shown to be able to detect 1080 in baits and then avoid eating them, making 1080 an unsuitable tool for the eradication of mice from the Sanctuary. Even if 1080 was an effective tool for an operation like this - which it is not - it would still be considered unsuitable in this location close to a city due to the high level of public opposition.

## 7.5 Evaluation of alternative eradication methods

Each of the methods outlined above is unlikely to meet either of the second and third criteria listed above for successful eradications, or both. It will be almost impossible to target every individual rat and mouse using trapping and ground-based poisoning, violating the second criterion. It is also highly unlikely that trapping will remove all individual rodents before they have a chance to breed and recolonise, thus violating the third criterion. Rats and mice can breed year-round if there is sufficient food available and reducing, but not eradicating, rodent populations reduces competition for food allowing survivors to have access to more resources.

An aerial 1080 operation will potentially meet the second and third criteria for most pest species; however, it is unlikely to successfully eradicate mice, as trials have shown that mice can detect and avoid 1080 in baits. This violates both the second and third criteria for this species, making aerial 1080 unsuitable for the eradication of all target species. Therefore, the only eradication method capable of successfully removing all target species is aerial application of Brodifacoum.

## 7.6 Evaluation of ongoing control instead of eradication

Control only, as opposed to total eradication, may benefit some native species, but would be highly unlikely to benefit all, and would place major limitations on the extent of possible subsequent ecological recovery. Control, whether by use of traps, alternative toxins or other methods, would require ongoing and/or multiple efforts over an extended and indefinite time period to achieve much less effectiveness, compared to what eradication can achieve in a single one-off effort. Control would create a greater long term negative effect through continued and repeated disturbance to the ecosystem and with a greater overall input of toxins into the environment or other control techniques such as trapping causing inadvertent damage to indigenous and non-target species. Ongoing long-term control option costs are financially prohibitive in comparison to eradication.

Control of rodents at ‘mainland island’ sites and places such as Great Barrier Island (Aotea) has led to beneficial responses in terrestrial bird populations e.g. Innes and Flux (1999), Beavan *et al.* (2000). Control of predators for terrestrial bird species has only been undertaken over the nesting period. There is little evidence to suggest that this kind of control will be of benefit to threatened species.

Attempts were made to control rats over small areas on Aotea (Great Barrier Island) using snap-trapping. The programme aimed to reduce rodent populations to 5% or less than their normal abundance during the summer period when ground dwelling species such as lizards are most active and breeding. After three years of intensive study, the work indicated that ship rat and kiore numbers could be reduced to around the 5% target. However, control efforts were frustrated by high rates of reinvasion and repopulation with rodent abundance often reaching 40% of normal levels, despite control efforts. Lizards monitored throughout the study showed no change in conspicuousness or increased abundance as a result of control efforts.

Similarly, no benefit to lizard populations could be measured at Pukerua Bay near Wellington despite three years of intensive rodent and mustelid control efforts (B. Edwards, pers. comm.). In contrast, intensive predator trapping at McCrae's Flat in Central Otago has achieved positive gains for resident lizard species in the core trapping area but trapping has the disadvantage of much higher risk of predator incursion, and high daily and on-going commitment costs, while providing little if any benefit to lizards in buffer trapping areas or outside the trapping network (Reardon *et al.* 2012).

The accomplishment of species and ecosystem recovery at the Sanctuary by controlling rodents is likely to be prohibited by the large fluctuations in abundance inherent in rodent populations. Cyclical high densities of rodents are likely to result in periods where control operations are likely to fail, spelling major setbacks to the recovery of vulnerable ground-dwelling species. Failure to control rodent populations by ground-based methods at 'mainland island' sites has been experienced in mast seeding years.

It is concluded that control would not permit the achievement of the conservation goal set for this operation. Control of mice would benefit some species but not others, and would not guarantee that further local extinctions as a result of rodent predation would not occur. The option of control would also mean the ongoing input of toxins into the ecosystems and ongoing risk of traps to non-target species.

On the basis of the above analysis, and based on the Department of Conservation's previous extensive experience with island rodent eradications, the aerial spread of cereal pellets containing brodifacoum (Pestoff® 20R) is the only method that can be expected to have a high probability of achieving eradication of rodents and a substantial number of other pest species from the sanctuary. It also achieves the objective of the operation at a realistic cost and with no more than minor impact on the natural environment and with minimal risk to humans. Other options are not practically feasible, are cost prohibitive and also carry a very high chance of failure.

# 8. CONSULTATION

The Trust has contacted affected parties in line with preliminary guidance from Nelson City Council. Consultation has been undertaken with iwi, neighbours, local authorities (Nelson City Council), Ministry of Health, Department of Conservation and Nelson and Marlborough Fish and Game, and Forest and Bird. Letters of support from the Department of Conservation, Fish and Game and Forest and Bird, and Dr David and Donna Butler are provided in Appendix 6.

## 8.1 Iwi

We have engaged with the iwi listed below, and received some informal responses requesting additional information, which we have provided, and are still awaiting formal responses.

- Tiakina Te Taiao Ltd
- Ngati Apa
- Ngati Toa Rangatira
- Te Atiawa o te Waka-a-Maui
- Rangitane o Wairau
- Ngati Kuia Trust
- Ngati Rarua Settlement Trust
- Te Pataka o Ngati Koata
- Ngati Tama ki Te Waiponamu Trust

## 8.2 Neighbours

The fenced Sanctuary has five neighbouring properties. The largest neighbour is the Nelson City Council (sharing *c*.80% of the boundary, Appendix 1). The other four properties are owned by Barry and Shirley Simpson, Craig Simpson, Dr Tamika Simpson and Mr Richard Sullivan (co-owners), and Dr David and Donna Butler. All neighbours together with their addresses are listed in Schedule 1.

A copy of this AEE along with the Resource Consent Application will be given to the four owners of the adjacent properties referred to in Schedule 1 as soon as the Application has been lodged, and accepted as complete by Nelson City Council.

## 8.3 Local authorities

The Sanctuary is vested in the Nelson City Council, and is leased to and managed by the Trust.

## 8.4 Ministry of Health

Consultation with the Nelson Medical Officer of Health has been undertaken and a copy of the Application and Assessment of Effects will be forwarded to the Medical Officer of Health as soon as the Application has been lodged and accepted as complete by Nelson City Council.

## 8.5 Consultation with other parties

Department of Conservation and Nelson Marlborough Fish & Game, and Forest and Bird have been consulted and have agreed to give Affected Persons Approvals. They will be lodged with Nelson City Council on receipt.

# 9. NOTIFICATION

It is submitted that notification of the Application should be on a limited basis to:

(i) Shirley A Simpson and Barry S Simpson

(ii) Craig D Simpson

(iii) Richard J Sullivan and Tamika Simpson

(iv) Iwi organisations:

- Tiakina Te Taiao Limited
- Ngati Apa
- Ngati Toa Rangatira
- Te Atiawa o te Waka-a-Maui
- Rangitane o Wairau
- Ngati Kuia Trust
- Ngati Rarua Settlement Trust
- Te Pataka o Ngati Koata
- Ngati Tama ki Te Waiponamu Trust

# 10. PROPOSED MONITORING

## 10.1 Operational success

The aerial application of Brodifacoum will be declared a success if no rodents are detected within the fenced Sanctuary following two years of monitoring. The overall pest control operation will be declared a success if stoats, possums, feral cats, feral goats, hedgehogs, deer, and feral pigs are removed from the Sanctuary within the same period.

An intensive monitoring programme - using traps and passive detection devices (e.g. tracking tunnels) - will be used to monitor pest mammals following the application of aerial Brodifacoum and other control measures described in this AEE. This monitoring is described in detail in a separate monitoring and mop up plan being prepared by Wildland Consultants Limited.

## 10.2 Bait monitoring

A universal degradation time for Brodifacoum baits has not been defined because of the effect that climatic conditions have on the process (Fisher *et al.* 2011). However, bait degradation times on Hauturu (Little Barrier Island) and at Tawharanui (Auckland) were similar with 96.5% of pellets completely breaking down in grassy sites within 120 days, while taking slightly longer in a forested area (Fisher *et al.* 2011).

It is proposed that the Sanctuary remains closed to the public until baits are no longer visible. Following the final aerial application, it is proposed that volunteers undertake bait monitoring along the various public tracks in the Sanctuary. Volunteers should score bait condition and report to the Trust using the bait condition scoring system described in Craddock (2003) and in the Code of Practice for Aerial and Hand Broadcast Application of Pestoff® Rodent Bait 20R (Appendix 3). When baits have degraded to a point where they are no longer visible, risks to non-target species will be greatly reduced (Fisher *et al.* 2010).

## 10.3 Soil and water quality

Data from previous aerial Brodifacoum operations suggest that water contamination is highly unlikely (Fisher 2010). This is because Brodifacoum has very low water solubility, which means it remains bound to organic material settling out in the sediments. For example, monitoring of water samples from aerial Brodifacoum (cereal pellet bait containing 20 ppm) operations on Red Mercury Island, Lady Alice Island, Little Barrier Island, and Rangitoto/Motutapu Islands have found no detectable Brodifacoum. At Maungatautari, a mainland fenced Sanctuary in the Waikato, 217 samples from two streams were tested following aerial Brodifacoum and the toxin was not detected (Fisher *et al.* 2011).

However, given that Brook Stream flows through residential Nelson, we propose that water samples are taken to (1) be absolutely certain there are no public health risks, and (2) provide data that will ease any public concerns. This should be done using a modified version of the methods used at Maungatautari. Water samples will be taken at the point where the Brook Stream leaves the fenced Sanctuary and at a further location *c.*800 m downstream. During each application of brodifacoum, samples should be taken at zero hours (baseline) then at 12, 24, and 48 hours following bait application. A further sample will be taken two weeks after the final application. Samples will be sent to an independent laboratory (Landcare Research) for processing and analysis. Brook Waimarama Sanctuary Trust will supply the monitoring results to Nelson City Council (as the consent authority), and to other interested parties in accordance with our Communications Plan. Additionally, Nelson City Council (and the Medical Officer of Health) will be notified immediately in the unlikely event that monitoring detects elevated levels of brodifacoum in Brook Stream.

When baits that land on the soil disintegrate, the Brodifacoum remains in the soil where it is highly immobile and is slowly broken down by micro-organisms. The half-life of Brodifacoum in soil varies from 12 to 25 weeks and depends on soil type, rainfall and other climatic conditions. Brodifacoum does not leach very far in the soil. The World Health Organisation found that only 2% of Brodifacoum added to soil leached more than 2 cm in four soil types tested (World Health Organisation 1995). Although bait degradation will be monitored (as described in Section 10.2), no soil monitoring is proposed, because this is a one-off eradication operation, and the Brodifacoum will break down in the soil over time.

## 10.4 Non-target species

The Brook Waimarama Trust has been carrying out five minute bird counts (5MBC) in the Sanctuary for several years. 5MBC are repeated quarterly along two transects each with 10 listening stations. To help with the establishment of a wildlife halo around the Sanctuary, Nelson City Council is currently designing a method of bird monitoring for use outside the Sanctuary. This is likely to include another 3-4 5MBC transects that will be surveyed three times per year. This monitoring will serve the dual purpose of (a) determining whether there is a reduction in any bird species following the aerial application of Brodifacoum; and (b) determining how strongly bird species respond to the absence of introduced mammalian predators within the Sanctuary. Because this is a one-off operation, Brodifacoum residues are not expected to persist in the liver of non-target species longer than one year (Fisher *et al.* 2011) and will not be monitored.

Invertebrates will be monitored using pitfall traps inside and outside the sanctuary prior to and after the operation. Reptiles are found at such low numbers in the site at present that no quantifiable monitoring is possible. We have a record of search effort from past surveys and we expect to achieve more detections utilising that same effort in the years following pest removal.

# 11. MEASLURES TO AVOID, MINIMISE, OR MITIGATE POTENTIAL ADVERSE EFFECTS

## 11.1 Public advice

The public will be notified two weeks prior to the first application of the bait. This will include notifying neighbouring landowners, hospital and police with two notices in the Nelson Evening Mail "*Public Notices*" column prior to aerial application of the toxic bait. The public will be excluded from the Sanctuary, and security guards will be present on the day of the bait application. The Sanctuary will be closed to the public from the time of first bait application until baits are no longer visible (see Section 10.2). In addition at least 20 warning signs will be placed around the sanctuary, including all major access points. Warning signs will follow the New Zealand Food Safety Authority's Code of Practice, and will remain in place for 12 months. Indicative copies of the style of the signs are provided in Appendix 4 (pre-application) and Appendix 5 (post-application).

## 11.2 Buffer zone within the fence

To ensure that no bait falls outside of the Sanctuary during aerial application, the operation will not be undertaken if winds are above 15 knots and no bait will be dropped within 5-10 m of the inside boundary of the predator exclusion fence. Helicopter pilots will use GPS equipment with pro-programmed routes to insure they stay within the buffer. A directional bucket (a bucket fitted with a defector to send baits inwards) and a trickle bucket will be used to sow bait to within 5-10 m of the inside of the fence, and bait would be hand sown along this buffer by Brook Waimarama Sanctuary Trust volunteers. Bait sowing will fully comply with the standards and performance measures in the Code of Practice for Aerial and Hand Broadcast Application of Pestoff Rodent Bait 20R for the Intended Eradication of Rodents from Specified Areas of New Zealand

## 11.3 Spill teams

During bait application it is recommended that teams of Trust volunteers walk the perimeter fence track checking for bait. If a mistake is made and bait is dropped over the fence, they would pick it up and throw it over the fence into the Sanctuary. A spill team would also be on hand at the loading zone to deal with any bait accidentally spilled there. At the end of each operational day the spill team will clean up the loading site following the guidelines in the New Zealand Food Safety Authority's

Code of Practice. This will include carefully checking the loading area immediately after the operation and recording and removing any bait found, then repeating this process 24 hours after bait application has ceased.

## 11.4 Bait-screens in streams

Bait screens should be placed in the Brook Stream where it exits the Sanctuary and in each of the side streams within the Sanctuary flowing into the Brook. These will catch any baits flowing down the stream. Screens would be checked at the end of each application and captured bait should be hand-placed into the Sanctuary, away from the streams. These will also be maintained and checked for a period of seven days after each application to collect any carcasses that are washed downstream, and will remain in place until the first significant rainfall event, at which time a final check will be made.

## 11.5 Destocking of adjacent paddocks

It is proposed that the Trust advises adjacent landowners to destock paddocks adjacent to the Sanctuary during the operation. The Trust will advise Mr Craig Simpson, Dr Tamika Simpson and Mr Richard Sullivan (co-owners), and Dr David and Donna Butler of each aerial Brodifacoum application not less than 48 hours before it occurs. The Trust will communicate this to landowners as part of implementing their communication strategy.

## 11.6 Weka

It is likely that weka will consume Brodifacoum baits and therefore will be highly vulnerable. Therefore, as discussed in Section 6.2.2., it is proposed to capture some weka within the Sanctuary prior to the operation and release them outside it at a site to be agreed with the Department of Conservation.

# 12. ASSESSMENT AGAINST RELEVANT PLANNING DOCUMENTS

An assessment of the activity against any relevant provisions of a document referred to in section 104(1)(b) of the Resource Management Act is provided separately in the Planning Assessment prepared by Dr. Lionel Solly, Department of Conservation, Whakatū/Nelson Office, Monro State Building, 186 Bridge Street, Nelson 7010.

# 13. CONCLUSIONS

Introduced mammalian pests are now the single biggest threat to indigenous biodiversity in New Zealand. Rodents, mustelids, feral cats, brushtail possums, hedgehogs, and feral pigs prey on our indigenous birds, reptiles, and invertebrates at rates that are driving various species to extinction. Brushtail possums, feral goats, deer, and feral pigs cause significant damage to indigenous forests and, over time, reduce regeneration and alter vegetation composition. The Brook Waimarama Sanctuary Trust cannot achieve its ecological restoration objectives within the Sanctuary without eradicating introduced mammalian pests. Significant finances and other resources have been dedicated to the construction of a pest-proof fence.

Eradication of mammalian pests from within the fenced Sanctuary will result in major conservation benefits associated with the proliferation of indigenous wildlife and vegetation. Nelson City Council have recently announced ten years of funding for biodiversity conservation, including work in a 'halo' around the Sanctuary. This effort, coupled with those of community groups and the Department of Conservation in high priority ultramafic ecosystems further inland, will ensure that the Sanctuary will also contribute to increased indigenous fauna across a huge area outside its boundaries.

Aerially-applied Brodifacoum has been used successfully to eradicate rats and mice from offshore islands and all the major fenced sanctuaries in New Zealand. While other tools, such as trapping, can be used to control species such as stoats and feral cats, they are not capable of eradicating rodents from the Sanctuary. Aerially-applied Brodifacoum may cause mortality of non-target indigenous species, but this will be confined to within the fenced Sanctuary if appropriate precautions are undertaken. However, once pests have been eradicated, indigenous wildlife will attain much higher population sizes than they are currently able to achieve in the presence of introduced predators. Also, highly vulnerable endangered species largely absent from mainland New Zealand will be able to be translocated and established within the Sanctuary. Risks to non-target domestic animals cannot be completely eliminated, but the Sanctuary has a small number of adjacent landowners and appropriate notification and adjacent paddock destocking will ensure these risks are minimal. Brodifacoum is not water soluble and baits sink to stream bottoms where it binds to sediments and slowly degrades. Contamination of the Brook Stream with Brodifacoum is extremely unlikely. Brodifacoum will break down in the soil within a matter of months and, because the operation is a one-off, residues will not linger in the food chain long-term.

Following the eradication of pest animals, the Brook Waimarama Sanctuary will become a landmark conservation initiative for Nelson, and an important education and recreation resource. Brook Waimarama Sanctuary Trust will be the second largest fenced sanctuary in New Zealand and the largest in the South Island. It will be the only fenced sanctuary in South Island beech forest. Given the size of the fenced area and the available habitat within it, the Sanctuary will also become a significant refuge for New Zealand's threatened plants and fauna.

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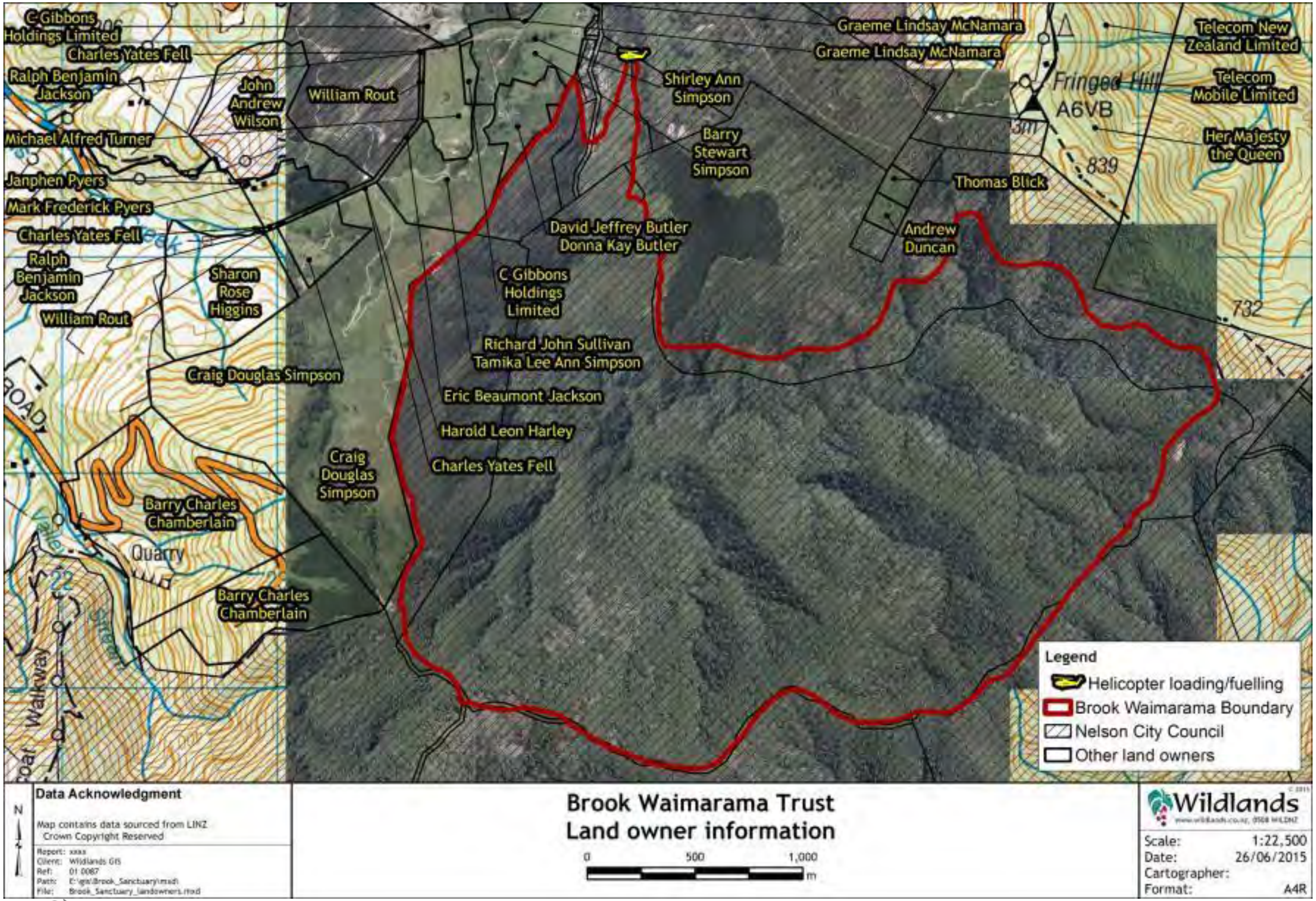
APPENDIX 1

BROOK WAIMARAMA
SANCTUARY SITE PLAN



C Gibbons Holdings Limited
Charles Yates Fell
Ralph Benjamin Jackson
John Andrew Wilson
William Rout
Michael Alfred Turner
Janphen Pyers
Mark Frederick Pyers
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Ralph Benjamin Jackson
Sharon Rose Higgins
William Rout
Craig Douglas Simpson
Craig Douglas Simpson
Barry Charles Chamberlain
Quarry
Barry Charles Chamberlain
Graeme Lindsay McNamara
Graeme Lindsay McNamara
Shirley Ann Simpson
Barry Stewart Simpson
David Jeffrey Butler
Donna Kay Butler
C Gibbons Holdings Limited
Richard John Sullivan
Tamika Lee Ann Simpson
Eric Beaumont Jackson
Harold Leon Harley
Charles Yates Fell
Thomas Blick
Andrew Duncan
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Telecom Mobile Limited
Her Majesty the Queen
Legend
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Brook Waimarama Boundary
Nelson City Council
Other land owners
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APPENDIX 2

# ADDITIONAL INFORMATION ON BRODIFACOUM

## Appendix 2: Review of [brodifacoum]

**This review describes and evaluates the pesticide(s) proposed for use in this operation.**

The following information on brodifacoum has been reproduced from the Pesticide Toxicology Manual – Information on Poisons used in New Zealand as Vertebrate Pesticides (Eason and Wickstrom 1997).

### BRODIFACOUM (TALON®, PESTOFF®)

Chemical Name: 3-[3-(4'-bromo-[1,1'-biphenyl]-4-yl)-1,2,3,4-tetrahydro-1- naphthalenyl]-4-hydroxy-2H-1-benzopyran-2-one.

Synonyms: Brodifacoum is the approved common name. Talon® and PESTOFF® are trade names

Brodifacoum is one of the most widely used rodenticides worldwide. It has been used in New Zealand to control possums since the early 1990s. On islands, aerial application techniques are used. On mainland New Zealand it is used in cereal baits in bait stations. In January 2000 the Department of Conservation announced plans to reduce the field use of brodifacoum on the mainland.

It is essential that wildlife do not gain access to areas where brodifacoum is being used. Brodifacoum can persist (>1 year) in the liver and kidneys of sub-lethally poisoned wildlife. Hence it is important that the risk of contamination of wildlife is recognised and the product is used carefully to minimise non-target contamination.

**Physical and chemical properties**

The empirical formula for brodifacoum is $C_{31}H_{23}BrO_3$ and the molecular weight is 523.4. It is an off-white to fawn-coloured odourless powder with a melting point of 228–232°C. It is of very low solubility in water (less than 10 mg/L at 20°C and pH 7). Brodifacoum is slightly soluble in alcohols and benzene, and soluble in acetone. It is stable at room temperature. Commercial concentrated solutions of brodifacoum are available for bait manufacturers.

**Historical development and use**

Brodifacoum is a synthetic compound that was developed a few decades ago. It is structurally related to a naturally occurring coumarin that causes haemorrhagic syndrome in cattle eating improperly cured or mouldy sweet clover. The rodenticidal properties of brodifacoum were described in the early 1970s. It is a very potent anticoagulant active against rats and mice, including strains resistant to warfarin and other anticoagulants (Rennison & Hadler 1975). A single ingestion of 1 mg/kg is usually sufficient to kill. In New Zealand it is used principally to control possums and rats, though it has also been used for rabbits (Williams et al. 1986a,b). In January 2000 the Department of Conservation took steps to reduce the mainland field use of brodifacoum because of concerns relating to contamination of birds and game (Eason et al. 1999). Because of the tendancy for uncontrolled exposure of non-targets through secondary poisoning (Eason et al. 1999), the suggested practice of secondary poisoning of stoats (Brown et al. 1998) is not recommended, particularly in areas where game may be hunted for human consumption.

Brodifacoum has been used successfully in recent rodent eradication programmes on New Zealand's offshore islands to protect populations of endangered indigenous birds (Taylor & Thomas 1989, 1993; Buckle & Fenn 1992; Robertson et al. 1993; Towns et al. 1993). In addition to its use to control and eradicate rodents, brodifacoum has been successfully used in ground-laid baits or in baits placed in bait stations to eradicate rabbits (Merton 1987; Towns et al. 1993), to control wallabies (D. Moore pers. comm.) and brushtail possums (Eason et al. 1993b). Field use of brodifacoum-containing baits for rabbit or wallaby control has been discontinued in New Zealand.

Cereal baits (Talon®, PESTOFF®) containing brodifacoum are used for rodent and possum control.

**Fate in the environment**

Brodifacoum is most unlikely to be found in water even after aerial application of baits for rodent control on offshore islands. Brodifacoum is not mobile in soil and is extremely insoluble in water (<10 mg/L water at pH 7). When baits disintegrate, brodifacoum will be likely to remain in the soil, where it will be slowly degraded by soil micro-organisms. The half-life in soil varies from 12 to 25 weeks depending on the soil type. Microbial degradation will be dependent on climatic factors such as temperature, and the presence of species able to degrade brodifacoum. In leaching studies, 2% of brodifacoum added to soil leached more than 2 cm in four soil types tested (World Health Organisation 1995).

Since brodifacoum remains absorbed in soil when baits disintegrate, only the erosion of soil itself would see any brodifacoum reaching water, and even then brodifacoum would be likely to remain bound to organic material and settle out in the sediment. If baits were sown directly into streams or rivers, localised short-term contamination might occur.

## Toxicology and pathology

### Onset of symptoms

The latent period between the time of ingestion and the onset of clinical signs varies considerably and in possums may take as long as 1-4 weeks (Littin et al. 2000). In rats the onset of symptoms and death usually occur within a week. Clinical signs reflect some manifestations of haemorrhage. Onset of signs may occur suddenly; this is especially true when haemorrhage of the cerebral vasculature or pericardial sac occurs. Clinical signs commonly include anaemia and weakness. Haemorrhaging may be visible around the nose, mouth, eyes, and anus of mammals. When pulmonary haemorrhage has occurred, blood-tinged froth may be visible around the nose and mouth. Swollen, tender joints are common and if haemorrhage involves the brain or central nervous system, ataxia or convulsions can occur. Poisoned animals die of multiple causes related to anaemia or hypovolemic shock.

**Mode of action**

Brodifacoum, like other anticoagulant toxicants, acts by interfering with the normal synthesis of vitamin K-dependent clotting factors in the liver of vertebrates (Hadler & Shadbolt 1975). In the liver cells the biologically inactive vitamin K1-2,3 epoxide is reduced by a microsomal enzyme into biologically active vitamin K, which is essential for the synthesis of prothrombin and other clotting factors (VII, IX, and X). Brodifacoum antagonism of the enzyme vitamin K1-epoxide reductase in the liver causes a gradual depletion of the active form of the vitamin, and consequently of vitamin K-dependent clotting factors, which results in an increase in blood-clotting time until the point where no clotting occurs.

The greater potency of second-generation anticoagulants such as brodifacoum compared to first-generation anticoagulants such as warfarin and pindone is likely to be related to their greater affinity for vitamin K-epoxide reductase and subsequent accumulation and persistence in the liver and kidneys after absorption (Huckle et al. 1988). Anticoagulants share this common binding site, but the second-generation anticoagulants have a greater binding affinity than the first-generation compounds (Parmar et al. 1987). All tissues that contain vitamin K-epoxide reductase (e.g. liver, kidney, and pancreas) are target organs for accumulating these toxicants.

**Pathology and regulatory toxicology**

Generalised haemorrhage is frequently evident at post-mortem. Areas commonly affected are the thoracic cavity, subcutaneous tissue, stomach, and intestine. The heart is sometimes rounded and flaccid with subepicardial and subendocardial haemorrhages. Histomorphological analysis of the liver may reveal centrilobular necrosis as a result of anaemia and hypoxia.

Various *in vitro* and *in vivo* studies (including the *Salmonella* reverse mutation assay, the forward mutation assay using mouse lymphoma cells, and the micronucleus test in rats and mice) have been undertaken to assess the genotoxic potential of brodifacoum. No mutagenic activity was detected. Brodifacoum, when given by oral gavage to female rats at daily dose levels of 0.001, 0.01, or 0.02 mg/kg body weight during days 6–15 of pregnancy, caused no evidence of adverse developmental effects on the foetuses. Higher daily doses (above 0.05 mg/kg) caused an anticoagulant effect in the dams, which resulted in a high incidence of abortion.

On the basis of these studies, brodifacoum can be classified as non-mutagenic and lacking in tetratogenic potential. In a 5-day study in rats, a no-observed-effect level for brodifacoum was 0.02 mg/kg/day (WHO 1995).

**Fate in Animals**

**Absorption, metabolism and excretion of brodifacoum compared with other anticoagulant toxicants.**

Brodifacoum is absorbed through the gastrointestinal tract. It can also be absorbed through the skin. After absorption, high concentrations in the liver are rapidly established and remain relatively constant. Disappearance from serum is slow with a half-life in rats of 156 hours or longer. The slow disappearance from the plasma and liver and the large liver: serum ratio probably contribute to the higher toxicity of brodifacoum when compared with warfarin or pindone (Bachmann & Sullivan 1983). It is apparent that a proportion of any ingested dose of brodifacoum bound in the liver, kidney, or pancreas remains in a stable form for some time and is only very slowly excreted.

In contrast to brodifacoum, warfarin will undergo relatively extensive metabolism. The metabolites will be more polar (water soluble) than the parent compounds and therefore more readily excreted in the urine.

Brodifacoum, like other second-generation metabolites, is not readily metabolised and the major route of excretion of unbound compound is through the faeces. Enterohepatic recirculation, the process that allows drugs and pesticides that have been absorbed to return to the gastrointestinal tract from the liver via the biliary tract, undoubtedly plays an important role.

Table 11 presents comparative data on the persistence of second-generation anticoagulants.

Parmar et al. (1987) found that elimination of radio-labelled brodifacoum, bromadiolone, and difenacoum from rat liver was biphasic, consisting of a rapid initial phase lasting from days 2 to 8 after dosing and a slower terminal phase when the elimination half-lives were 130, 170, and 120 days, respectively. Elimination of coumatetralyl was more rapid, with a half-life of 55 days.

After a single oral $^{14}C$-difenacoum dose of 1.2 mg/kg body weight, the highest concentration of radioactivity (41.5% of the dose) was found in the rat liver 24 hours after dosing. The elimination from the liver was biphasic. The half-life of elimination of the radioactivity during the first rapid phase was 3 days, and for the slower phase was 118 days. A similar biphasic elimination was also apparent in the kidney. In the pancreas the concentration declined more slowly than in any of the other tissues (182 days). The parent compound was the major component in the liver 24 hours after dosing (42%).

Unchanged flocoumafen comprised the major proportion of the hepatic radioactivity in rats and was eliminated with a half-life of 220 days (Huckle et al. 1989).

TABLE 11. PERSISTENCE OF SECOND-GENERATION ANTICOAGULANTS

| | SPECIES | BLOOD t½ (hours)† (except where specified) | LIVER RETENTION‡ (days) | REFERENCES |
|---|---|---|---|---|
| Difenacoum | Rat | | t½ 120 | Breckenridge et al. |
| | Rabbit | - | - | 1985 |
| | | 83 | | |
| Bromadiolone | Rat | 26–57 | | Kamil 1987 |
| | Rat | 25–26 | t½ 170 | Parmar et al. 1987 |
| | Sheep | - | 256 | Nelson & Hickling |
| | | | | 1994 |
| Flocoumafen | Rat | - | t½ 220 | Huckle et al. 1989 |
| | Sheep | - | >128 | Nelson & Hickling |
| | Quail | - | t½ 155 | 1994 |
| | Dog | - | >300 | Huckle & Warburton |
| | | | | 1989 |
| | | | | Veenstra et al. 1991 |
| Brodifacoum | Rat | 156 | >80 | Bachmann & Sullivan |
| | Rat | - | t½ 130 | 1983 |
| | Rabbit | 60 | - | Parmar et al. 1987 |
| | Dog | 6 days | - | Breckenridge et al. |
| | Dog | 0.9–4.7 days | - | 1985 |
| | | (mean 2.8) | | Woody et al. 1992 |
| | Possum | 20–30 days | >252 | Robben et al. 1998 |
| | Sheep | - | >250 | |
| | Human | 16–36 | | Eason et al. 1996c,d |
| | | | | Laas et al. 1985 |
| | | | | Weitzel et al. 1990 |
| Difethialone | Rat | 2.3 days | t½ 108 § | Lechevin & Poche |
| | Dog | 2.2–3.2 days | | 1988 |
| | | | | Robben et al. 1998 |

† t½ for plasma or liver is the elimination half-life. It is standard convention to report the elimination t½ (β-phase) rather than the α-phase.

‡ Liver retention is expressed as the time period for which residues are reported to persist in the liver unless the value is preceded by t½. Plasma is t½ unless otherwise specified.

§ The half-life hepatic elimination for difethialone reported by Lechevin & Poche (1988) is unusually short for a second-generation anticoagulant, which suggests that difethialone may be unique.

There is limited data on the persistence of anticoagulants in New Zealand native species. In a study in weta, brodifacoum persisted for approximately 1 week after dosing (Morgan et al. 1996).

**Species variation in response to brodifacoum**

For second-generation anticoagulants like brodifacoum only a single dose is needed to induce death, if sufficient toxicant is ingested, and brodifacoum is extremely toxic in a number of animal species. The toxicity of brodifacoum varies between mammal species (Table 12) and bird species (Table 13).

In most mammals $LD_{50}$ values are 1 mg/kg or less. Some higher values are reported in sheep and dogs, but there is considerable variability in these reports ($LD_{50}$ in sheep 5-25 mg/kg and in dogs 0.25-3.56 mg/kg).

It has been suggested that anticoagulants are unlikely to affect invertebrates, which have different blood-clotting systems from vertebrates (Shirer 1992) and a New Zealand-based study has shown that brodifacoum lacks insecticidal properties in weta (Morgan et al. 1996).

Small birds such as silvereyes, sparrows, blackbirds, and California quail are considered more resistant to brodifacoum than some larger birds such as southern black-backed gulls, Canada geese, and pukeko (Godfrey 1985). However, some large birds, including Australasian harriers, ring-necked pheasants, and paradise shelducks, are also relatively resistant.

**Aquatic toxicology**

There are limited data on the aquatic toxicology of brodifacoum. In the unlikely event of a significant amount of brodifacoum bait being applied directly to a small stream, poisoning of aquatic invertebrates and fish could result. The $EC_{50}$ from *Daphnia magna* (first instar) was 1.0 mg/kg after 24 hours of exposure and 0.34 mg/kg after 48 hours using 50 ppm pelleted baits. The $LC_{50}$ (24 hours) for rainbow trout is 0.155 mg/L. The $LC_{50}$s (96 hours) for rainbow trout and bluegill are 0.05 and 0.165 mg/L, respectively (World Health Organisation 1995.

TABLE 12. ACUTE ORAL TOXICITY ($LD_{50}$mg/kg) OF BRODIFACOUM FOR MAMMAL SPECIES (Godfrey 1985, Eason & Spurr 1995)

| SPECIES | $LD_{50}$ (mg/kg) |
|---|---|
| Pig | 0.1 |
| Possum | 0.17 |
| Rabbit | 0.2 |
| Cat | 0.25–25 |
| Dog | 0.25–3.56 |
| Rat | 0.27 |
| Mouse | 0.4 |
| Bennett's wallaby | 1.3 |
| Sheep | 5–25 |

TABLE 13: ACUTE ORAL TOXICITY ($LD_{50}$mg/kg) OF BRODIFACOUM FOR BIRD SPECIES (Godfrey 1985)

| BIRD SPECIES | $LD_{50}$ (mg/kg) |
|---|---|
| Southern black-backed gull | <0.75† |
| Canada goose | <0.75† |
| Pukeko | 0.95 |
| Blackbird | >3.0‡ |
| Hedge sparrow | >3.0‡ |
| California quail | 3.3 |
| Mallard duck | 4.6 |
| Black-billed gull | <5.0† |
| House sparrow | >6.0‡ |
| Silvereye | >6.0‡ |
| Australasian harrier | 10.0 |
| Ring-necked pheasant | 10.0 |
| Paradise shelduck | >20.0‡ |

† Lowest dose tested ‡ Highest dose tested

**Non-target effects**

Brodifacoum has the potential to cause both primary and secondary poisoning of non-target species. However, as with the other vertebrate pesticides, the adverse effects of brodifacoum on wildlife are dependent more on how baits are used and the behaviour of non-target species than susceptibility of individual species to the toxin. Baits in bait stations are less accessible to non-target species than baits on the ground. Secondary poisoning of birds is likely where target species (e.g. rabbits and rats) are a major constituent of the diet (e.g. weka and harriers).

Despite these distinctions, a wide range of small and large birds have been found dead from primary or secondary poisoning after field use of brodifacoum in New Zealand: saddlebacks, blackbirds, chaffinches, house sparrows, hedge sparrows, silvereyes, song thrushes, paradise shelducks, Australian magpies, robins, western weka, Stewart Island weka and brown skuas (Towns et al. 1993; Williams et al. 1986a,b; Taylor & Thomas 1993; Taylor 1984; )

These findings suggest that the reported differences in sensitivity (from published $LD_{50}$ values; see Table 13) may be either inaccurate or irrelevant predictors of susceptibility to brodifacoum, since species such as house sparrows, silvereyes, and paradise shelducks are reported to be moderately resistant.

The impacts of brodifacoum-poisoning operations on populations of non-target species that might have eaten baits have been monitored in several studies. Numbers of three indigenous bird species (western weka, Stewart Island weka, and pukeko) have been severely reduced in poison areas. For example all 15 banded western weka and more than 98% of the unbanded weka were killed on Nukuwaiata Island, following the use of Talon® 7-20 at 11 kg/ha in 1993 (Brown 1997).

However, despite deaths of some individuals, populations of other bird species have been less affected. For example, on Stanley Island 41 of 43 banded North Island saddlebacks were still alive more than 1 month after aerial distribution of Talon® 20P (Towns et al. 1993). On Red Mercury Island, all nine little spotted kiwi with radio transmitters were still alive 1 month after aerial distribution of Talon® 20P (Robertson et al. 1993). On Tiritiri Matangi Island, little spotted kiwi, North Island saddlebacks, and North Island robin populations were not detrimentally affected by aerial distribution of Talon® 20P (C.R. Veitch pers. comm.). The South Island robin population on Breaksea Island was not detrimentally affected by the use of Talon® 50WB in bait stations (Taylor & Thomas 1993). Brodifacoum residues have been detected in dead birds after aerial application of baits for rodent eradication (Morgan et al. 1996a), but the extent of wildlife contamination and impact after continued use has not been comprehensively studied.

There are no published $LD_{50}$ data on the direct acute toxicity of brodifacoum to New Zealand bats. However, data from other anticoagulants suggest they may be susceptible if they were to consume the toxin.

There are no published $LD_{50}$ data on the acute toxicity of brodifacoum to reptiles or amphibians. However, reptiles, at least, are known to be susceptible to brodifacoum. Telfair's skinks (*Leiolopisma telfairii*) were found dead after eating rain-softened Talon® 20P used for rabbit eradication on Round Island, Mauritius, and post-mortem analyses revealed brodifacoum concentrations of 0.6 mg/kg in samples of liver (Merton 1987). Skink numbers have increased markedly since the removal of rabbits (North et al. 1994). In New Zealand, lizard numbers increased after use of Talon® 20P to eradicate rabbits and rats on Stanley Island (Towns et al. 1993). Two months after Talon® 20P was aerially sown at 17.5 kg/ and Talon® 50 WB hand-laying at 1 kg/ha on Stanley Island, lizard pitfall capture rates were 29% higher than the previous best (Towns et al. 1993). Brown (1997) reported that the *Oligosoma lineoocellatum* population on Nukuwaiata Island increased by 67% over the two years following the aerial application of Aerial Talon® 7-20 at 11 kg/ha to remove rat and weka.

It is considered that invertebrates are unlikely to be directly killed by brodifacoum (Shirer 1992; Morgan et al. 1996a). No effect was found on **ground weta** (*Hemiandrus spp*) and **cave weta** (*Pleioplectron simplex*) held in captivity and allowed to feed freely for 47 days on Talon 50WB® wax baits containing 0.05 mg/kg brodifacoum. Mortality observed over the study period was not significantly different between treatment and non-treatment groups. The mean weight of surviving weta in both groups declined over the period but the difference in weight loss between groups was not significant (Bowie and Ross 2006).

Contaminated invertebrates may pose a risk of secondary poisoning to insectivorous vertebrates. However, recent studies have shown that brodifacoum does not persist in weta. If there is a similar lack of persistence in other invertebrates, then the risk of secondary poisoning via invertebrates would be short-lived. However, at this time the persistence of brodifacoum in molluscs has not been elucidated. Molluscs have a hepato-pancreas; in mammals anticoagulant rodenticides binds to vitamin K epoxide reductase in both the pancreas and the liver. It is therefore conceivable that the hepato-pancreas is a target organ in molluscs.

**Secondary poisoning**

The risk of secondary poisoning to non-target species is far greater from second-generation anticoagulants such as brodifacoum than from first-generation anticoagulants such as warfarin, because second-generation compounds are not substantially metabolised and excreted before death. For example, five out of six owls died after feeding on rats killed by brodifacoum for 8–11 days (Mendenhall & Pank 1980).

The only confirmed report of secondary poisoning of insectivorous birds with brodifacoum was in a zoo, where avocets, rufous-throated ant pittas, golden plovers, honey creepers, finches, thrushes, warblers, and crakes died in an aviary after feeding on pavement ants and cockroaches that had eaten brodifacoum baits (Godfrey 1985). However, the potential for invertebrates to 'carry' poison to birds has been suggested (Stephenson et al. 1999).

In New Zealand, predator and scavenger populations have been monitored during five brodifacoum-poisoning operations. Comparable numbers of brown skuas and New Zealand falcons, the main avian predators at risk, were seen before and after the use of Talon® 50WB in bait stations for eradication of Norway rats on Hawea Island (Taylor & Thomas 1989). There was no evidence of New Zealand falcons or moreporks being killed by use of Talon® 50WB in bait stations for eradication of Norway rats on Breaksea Island (Taylor & Thomas 1993). There was no evidence of a detrimental effect on populations of moreporks on Stanley Island (Towns et al. 1993) or Red Mercury Island (Robertson et al. 1993) after aerial distribution of Talon® 20P for eradication of kiore. Moreporks decreased after the aerial distribution of Talon® 20P at 10 kg/ha on Tiritiri Matangi Island, 1993, but it is not known whether this was induced by poisoning or the removal of their major food item, rats (Eason et al. 2002). Five-minute bird counts undertaken before and after the rat eradication on Red Mercury Island (Talon® 20P pellet aerially sown at 15.5 kg/ha and some hand laying of Talon® 50WB) indicated no change in the harrier population post eradication (Robertson et al. 1993).

The perceived hazards of secondary poisoning to non-target wildlife have restricted second-generation anticoagulants such as brodifacoum from being registered for field use in the USA (Colvin et al. 1991). The detection of brodifacoum residues in a range of wildlife including native birds such as kiwi (*Apteryx* spp.) (Robertson et al. 1993), raises serious concerns about the long-term effects of broad-scale field use of brodifacoum in New Zealand. This is compounded by the recent detection of residues in a wide range of species: weka, morepork, Australian harrier, pukeko, grey duck, mallard, black-backed gull, robin, saddleback, chaffinch, mynah, magpie, and blackbird (Murphy et al. 1998; Dowding et al. 1999). Of far less concern was the detection of brodifacoum in cats and stoats, introduced species regarded as pests and largely responsible for the decline of native birds, such as kiwi. Nevertheless, because of the potential for uncontrolled contamination of wildlife (demonstrated by field survey data) broad-scale field use of brodifacoum in New Zealand (Eason et al. 1999, 2000) is currently being restricted by the Department of Conservation.

In summary, indigenous New Zealand birds most at risk from feeding directly on cereal-based baits containing brodifacoum are those species that are naturally inquisitive and have an omnivorous diet (e.g. weka, pukeko, brown skua, and kea). The risk of secondary poisoning is probably greatest for predatory and scavenging birds (especially the weka, brown skua, Australasian harrier, morepork, and southern black-backed gull) that feed on target species (e.g. live or dead rats and mice and rats, rabbits, and possums). Recently published surveys by Department of Conservation and Landcare Research staff clearly demonstrate widespread wildlife contamination that extends to native birds as well as game species (Murphy et al. 1999; Gillies & Pierce 1999; Dowding et al. 1999; Meenken et al. 1999; Eason et al. 1999c; Robertson et al. 1999a; Stephenson et al. 1999). This pattern is mirrored overseas where there is field use of second-generation anticoagulants (Young & de Lai 1997; Shore et al. 1999; Stone et al. 1999).

The risks of non-target mortality and contamination after pest control must be carefully balanced against the benefits. The eradication of rabbits using brodifacoum on Round Island, Mauritius, in 1986 illustrates this most clearly. Telfair's skinks and other lizards on the island were considered at risk from poisoning by eating poisoned insects and/or bait and some were killed (Merton 1987). Three years after eradication of the rabbits there has been a dramatic regeneration of vegetation and marked increases in the numbers of lizards, including Telfair's skink (North et al. 1994). In New Zealand, the benefits of using brodifacoum (or related compounds) to eradicate rats and/or rabbits from offshore islands are also becoming apparent. For example, eradication of rats from Korapuki Island (using bromadiolone, a second-generation anticoagulant related to brodifacoum) in 1986 resulted in a 10-fold increase in lizard numbers in 3 years (Towns 1991) and a 30-fold increase in 6 years (Towns 1994). Similarly, in 1996, the successful removal of rats from Kapiti Island has resulted in a significantly improved survival rate for stitchbirds and saddlebacks, and benefits to other taxa are expected (Empson & Miskelly 1999).

**Summary**

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Generally available and no licence required.<br><br>Effective against possums that have developed poison/bait shyness and<br>Effective for rodent control<br>Antidote available | High risk of secondary poisoning of non-target species<br>Persistent (>9 months) in liver of vertebrates (can enter food chain and put meat for human consumption at risk)<br>Although an antidote (vitamin K) is available, long-term treatment is needed<br>Expensive compared to 1080 or cyanide<br>Possums can eat excessive amounts of bait (increase costs)<br>Possums take 2–4 weeks to die |

- Brodifacoum is a synthetic pesticide that was developed approximately 20 years ago.

- Brodifacoum is not readily soluble. It binds strongly to soil and is slowly degraded. It is most unlikely to significantly contaminate waterways unless large amounts of baits enter streams.

- It is a potent anticoagulant, which acts by interfering with the synthesis of vitamin K-dependent clotting factors. Brodifacoum is toxic to mammals, birds, and reptiles.

- Brodifacoum is extremely persistent in the livers of lethally poisoned, and to a lesser extent the meat of sub-lethally poisoned, animals, which heightens the risk of secondary poisoning of non-target species.

- Livestock must not be allowed access to brodifacoum baits as residues may persist in survivors of a sub-lethal dose for >9 months.

- Non-target effects on individual birds of a number of species have occurred after brodifacoum use for rodent control.

- Adverse effects on individual populations of a number of species of birds have been observed after brodifacoum use for rodent control. However, short-term losses are likely to be superseded by long-term gains once predators have been removed.

### A.3 Effects on Non-Target Species (Section 5, Part II)

*Secondary poisoning*
Secondary poisoning of insectivorous species as a result of the operation is considered unlikely. Laboratory studies show that invertebrates are unlikely to accumulate brodifacoum as it is eliminated quickly through metabolism and/or excretion (Morgan *et al.* 1996). Correspondingly, the concentration of brodifacoum found in invertebrates collected after poison operations has been low, indicating that very large numbers of contaminated invertebrates would need to be consumed in a relatively short period to cause mortality (Morgan and Wright 1995). No invertebrates tested following the Stanley Island operation were found to have traces of brodifacoum (Towns *et al* 1993).

Secondary poisoning from eating dead or dying rodents is possible, but is likely to impact on only a very small number of species. Species considered most vulnerable include morepork, black-backed gull, and weka. Experience gained from other aerial poisoning operations suggest these species (other than weka) are not at risk at the population level.

*Marine environment*
Brodifacoum is most unlikely to be found in water even after aerial application of baits for rodent control. Because of its insolubility (<10 mg/l water at pH 7), when baits disintegrate, brodifacoum is likely to remain in the soil where it will be slowly degraded by soil micro-organisms. Consequently, only erosion of the soil itself would see any brodifacoum reaching water, and even then brodifacoum would remain absorbed in organic material and settle out in the sediment. Baits sown on land therefore pose a negligible risk to marine fauna.

When immersed the baits break down rapidly and the particles will disperse. For the aerial poisoning with brodifacoum on Kapiti Island (11kg/ha followed by 6kg/ha) it was estimated that accidental discharge of the toxin over the sea will account for 0.0000006 mg/l, or about seven orders of magnitude lower than the level (LD50 (96h) 0.165 mg/l) known to be toxic to some fish species (Empson 1996).

It is possible that some marine fish will consume whole baits before breakdown occurs. However, the amount of bait presented, in comparison to the marine area exposed, and number of fish present will see no species at risk at a population level.

A study of marine fish was undertaken during the Kapiti Island rat eradication (Cole and Singleton 1996). They could find no evidence for a reduction in fish populations. Similarly no marine life was found dead as a result of poisoning, following a brodifacoum spill at Kaikoura in May 2001. This spill consisted of 18 tonnes of Pestoff 20R (the same bait to be used for the KPMI operation) entering the sea at a single point following a truck accident (equivalent to 0.360 kg of brodifacoum).

APPENDIX 3

# BAIT CONDITIONS SCORING

APPENDIX 3

# BAIT CONDITIONS SCORING

Extracted from: New Zealand Food Safety Authority's Code of Practice: Aerial and Hand Broadcast Application of Pestoff® Rodent Bait 20R for the Intended Eradication of Rodents from Specified Areas of New Zealand.

## 3.4 Bait Condition Scoring

- **Condition 1:** Fresh Pellets/Pellets not discernable from fresh bait.
- **Condition 2:** Soft pellets. <50% of pellet matrix is or has been soft or moist. Bait is still recognisable as a distinct cylindrical pellet, however cylinder may have lost its smooth sides. <50% of bait may have mould. Bait has lost little or no volume.
- **Condition 3:** Mushy Pellet. >50% of bait matrix is or has been soft or moist. <50% of pellet has lost its distinct cylindrical shape. >50% of bait may have mould. Bait may have lost some volume.
- **Condition 4:** Pile of Mush. 100% of bait matrix is or has been soft or moist. Pellet has lost distinct cylindrical shape and resembles a pile of mush with some of the grain particles in the bait matrix showing distinct separation from the main pile. >50% of bait may have mould. Bait has lost some volume.
- **Condition 5:** Disintegrating Pile of Mush: 100% of bait matrix is or has been soft or moist. Pellet has completely lost distinct cylindrical shape and resembles a pile of mush with >50% of the grain particles in the bait matrix showing distinct separation from each other and the main pile. >50% of bait may have mould. Bait has definitely lost a significant amount of volume.
- **Condition 6:** Bait Gone: Bait is gone or is recognisable as only a few separated particles of grain or wax flakes.

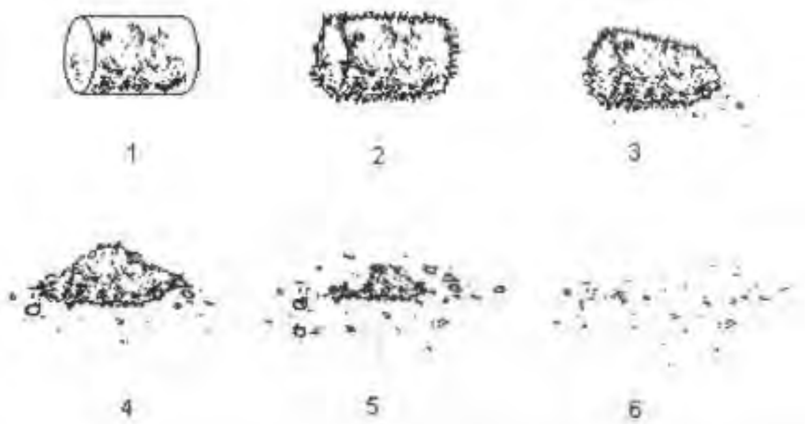


Illustration of typical bait condition at each ordinal score used in the trial
(figure reproduced from Craddock, 2004)

APPENDIX 4

PRE-APPLICATION
WARNING SIGN

# WARNING POISON

## Brodifacoum

**WILL BE APPLIED in the Sanctuary from 1 June 2016 – 30 September 2016**

**PHOTO OF BAIT**

- **DO NOT touch bait**
- **WATCH CHILDREN at all times**
- **DO NOT EAT animals from this area**
- **Poison baits or carcasses are DEADLY TO DOGS**

**For more information contact:**

**The Manager**
**Brook Waimarama Sanctuary Trust  Phone (03) 546 2422**

*Unauthorised removal of signs or baits is an offence*

POST-APPLICATION
WARNING SIGN

# WARNING POISON

# Brodifacoum

**IS PRESENT in the Sanctuary from 1 June 2016 – 30 September 2016**

PHOTO OF BAIT

- **DO NOT touch bait**
- **WATCH CHILDREN at all times**
- **DO NOT EAT animals from this area**
- **Poison baits or carcasses are**
  **DEADLY TO DOGS**

**For more information contact:**

**The Manager**
**Brook Waimarama Sanctuary Trust Phone (03) 546 2422**

The Brook Waimarama Sanctuary Nelson New Zealand

*Unauthorised removal of signs or baits is an offence*

APPENDIX 6

LETTERS OF SUPPORT

588 Brook Street
NELSON
7010

7 September 2015

Hudson Dodd
General Manager
Brook Waimarama Sanctuary Trust
PO Box 744
NELSON

By Email

Dear Hudson

**AERIAL POISONING OPERATION**

We are writing as neighbours of the Brook Waimarama Sanctuary to express our strong support for the planned operation to eradicate mammalian pests from the site, through the aerial application of baits containing the toxin brodifacoum.

We recognise that this is the only proven technique that can achieve the desired objective and that it is being designed to have an impact confined to the Sanctuary site. We know that any minor losses of individual birds will be hugely offset by the increased productivity that follows the elimination of predators. We are confident of the Trust's ability to run a safe operation.

We look forward to timely communication from the Trust about the details of the operation and the timing of its component aerial drops. We have one paddock close to the boundary with the Sanctuary and will be able to exclude sheep from this at the time of the operation.

Good luck with your planning for this important operation.

Yours sincerely

David Butler

Donna Butler 8th Sept. 2015.

Department of Conservation
*Te Papa Atawhai*

DOC-2570282

25 August 2015

Hudson Dodd
General Manager
Brook Waimarama Sanctuary
P O Box 744
Nelson 7040

Dear Hudson

**Brook Waimarama Sanctuary Trust:**
**Application for resource consent for pest animal eradication operations**

I am pleased to provide this letter in support of the application by the Brook Waimarama Sanctuary Trust (the Trust) for resource consent(s) to undertake pest animal eradication operations within the fenced sanctuary in the Brook Valley.

The Brook Waimarama Sanctuary is a community initiative to create a pest-free sanctuary for native flora and fauna just a few kilometres from the heart of Nelson city. The site is contiguous with other protected land that extends into Mount Richmond Forest Park.

The Trust's goals for the sanctuary are recognised in, and consistent with, the Nelson Biodiversity Strategy. One of the objectives of the Strategy is that "*native biological diversity is restored, enhanced and, where appropriate, connected*"; and "*supporting the flagship Brook Waimarama Sanctuary restoration*" is one of the Strategy's priority actions.

Eradication of pest animals within the fenced sanctuary has always been an integral part of the Trust's vision, and is necessary to achieve objectives for restoration and re-introduction of native fauna and flora.

The Department of Conservation (the Department) has been actively involved with this project since its inception. The former Nelson Marlborough Conservator, Neil Clifton, was a signatory to the Deed of Charitable Trust which established the Trust. As provided for in the Trust Deed the Department has been represented on the Trust Board from the outset; however, the Department has not appointed a representative to the Board since 2013.

The Department has provided ongoing technical assistance and advice to the Trust. This included ecological and planning advice to assist the Trust in obtaining resource consent to build the pest-proof fence (which is now under construction). The Department continues to offer advice and support to the Trust as required.

The Trust has also received funding from the Community Conservation Partnerships Fund, which is administered by the Department, for projects associated with completion of the sanctuary.

**Department of Conservation *Te Papa Atawhai***
Motueka Office
PO Box 97, Motueka 7143
www.doc.govt.nz

Once the fence has been completed the Brook Waimarama Sanctuary will be the largest fenced sanctuary in the South Island. Large catchment based predator fenced sanctuaries on mainland New Zealand have an important role in the protection and restoration of threatened indigenous ecosystems.

Fenced sanctuaries allow for the complete eradication of introduced mammalian pests (including rats, mustelids and possums) within the fenced area, rather than simply managing these pests to low numbers. This provides benefits for native species that are particularly vulnerable to even low levels of predation, or which are preferentially selected by mammalian herbivores (e.g. mistletoe). A fenced sanctuary in the Brook Valley would therefore benefit existing native plant communities and populations of native birds, lizards and invertebrates; and would allow for re-introduction of species that previously occurred in the area, including species that are classified as threatened or at risk under the New Zealand threat classification system. The sanctuary, with its pest-proof fence in place, will have a valuable role to play as a safe haven for some of our most endangered wildlife.

Successful eradication of pest animals such as rats and possums over large areas can only be achieved through application of vertebrate toxins, with aerial application of brodifiacoum being the only proven and effective method for eradicating rodents (rats and mice) from islands and mainland fenced sanctuaries.

The success of the eradication operation is dependent on the development of a robust operational plan, and its proper implementation. The operational plan should address the detailed methodology for conducting the operation, including procedures for managing risks (including impacts on non-target species); and should identify key personnel and their responsibilities (before, during and after the operation). The operational plan must be consistent with the conditions imposed on any resource consent(s) that may be granted for the application of brodifacoum (or other vertebrate toxins); but it is also important that resource consent conditions are informed by operational requirements and do not compromise the effectiveness of the proposed operation.

I understand that an operational plan is currently in preparation, and anticipate that the Department will be given further opportunity to comment on this in due course.

As the operational plan is still in development, some matters of detail that are of interest to the Department are still to be addressed. However, I can confirm that, in principle, the Department supports the application to undertake pest animal eradication operations within the fenced sanctuary, to ensure the vision for the sanctuary can be achieved.

Yours sincerely

Chris Golding
Conservation Services Manager, Motueka

Fish & Game
NEW ZEALAND

10 July 2015

Grant Harper
Operations Manager
Brook Waimarama Sanctuary

Dear Grant,

Thank you for meeting with Fish & Game in regards to the planned pest eradication taking place next year, using brodifacoum. From a Fish & Game perspective, we fully support the Brook Waimarara project and are satisfied with your mitigation measures, which include using a sediment trap and taking water samples.

All the best with your project.

Yours faithfully,

Jacob Lucas
Nelson Marlborough Fish & Game Field Officer

Nelson Marlborough Region

66 Champion Rd, Richmond, P O Box 2173, Stoke, Nelson. Telephone 03 544 6382 Facsimile 03 544 4058

Forest & Bird
GIVING NATURE A VOICE
Royal Forest and Bird Protection
Society of New Zealand Inc.

Nelson/Tasman Branch
P O Box 7126,
Nelson Mail Centre
7010
Nelsontasman.branch@forestandbird.org.nz
15 July 2015

Grant Harper
Acting Operations Manager
Brook Waimarama sanctuary
Nelson

**Brook Sanctuary pest eradication**

Dear Grant

The Nelson/Tasman Forest and Bird committee accepts that your team will make every effort to accurately target the species to be eradicated using broudifacum within the sanctuary.

We support this one-off aerial baiting operation.

Kind regards

Gillian Pollock

Branch secretary

# SCHEDULE 1

## SCHEDULE 1

| | | |
|---|---|---|
| 1. | Shirley Ann Simpson | 584 Brook Street, Nelson 7010 |
| 2. | Barry D Simpson | Upper Brook Street, Nelson 7010 |
| 3. | Craig D Simpson | Upper Brook Street, Nelson 7010 |
| 4. | Richard J Sullivan and Tamika Simpson | Upper Brook Street, Nelson 7010 |
| 5. | The Iwi: | |
| | - Te Atoawa | 210 Waikawa Road, Waikawa 7220 |
| | - Ngati Rarua | 28 Grove Road, Blenheim 7201 |
| | - Ngati Kuia | 25 Vickerman Street, Port Nelson, Nelson 7010 |
| | - Ngati Koata | PO Box 1659, Nelson 7040<br>137 Vickerman Street, Port Nelson, Nelson 7010 |
| | - Ngati Tama | PO Box 914, Nelson 7040 |
| | - Ngati Apa | 161 Bridge Street, Bulls 4818<br>PO Box 103, Bulls 4863 |
| | - Rangitane o Wairau | Level 4, Rangitane House<br>2 Main Street, Blenheim 7201 |
| | - Ngati Toa Rangatira | 26 Ngatitoa Street, Takapuwahia, Porirua 5022 |

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