Managing rodents on the New Zealand mainland—what options are currently available?

Summary of a workshop session at the Department of Conservation 'mainland island' hui, Omapere, 20–23 August 2001

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Session notes compiled by Craig Gillies

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ABSTRACT

Since late 1998, staff at most Department of Conservation 'mainland island' sites have been investigating alternatives to brodifacoum-laced baits laid in bait stations for controlling rodents. A workshop session was held as part of the 2001 annual 'mainland island' hui (meeting) to review and discuss the different rodent control techniques tried by managers on the New Zealand mainland since 1998, and to make recommendations regarding the issues surrounding the different techniques. The consensus was that currently there are two main options (other than brodifacoum) available for rodent control on the New Zealand mainland: kill-trapping and a range of other toxins (1080, cholecalciferol, warfarin and pindone). The main reported advantage of trapping was that the technique has a much greater public acceptance than toxins. Toxins, however, were reported to be less labour-intensive than trapping and can be used over relatively large areas. The most commonly expressed concern was that very little is understood about the impacts of mice and what techniques are available to control them.

Keywords: rodent control; mainland islands; toxins; trapping

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1. Introduction

During 1995 and 1996, six 'mainland island' ecological restoration programmes were set up using funds specifically allocated for this purpose (Saunders 2000). An important common feature of these projects is the development and refinement of intensive pest management techniques (Saunders 2000). Control of rodent densities to levels low enough to help achieve the stated ecosystem restoration goals is carried out at five of these 'mainland islands': Trounson Kauri Park (Leach 2000), Northern Te Urewera (Burns et al. 2000), Boundary Stream (McRitchie 2000), Rotoiti (Butler 2000) and in the Hurunui (Grant & King 2001).

Until very recently brodifacoum was the poison most commonly used by the Department of Conservation (DOC) for controlling rodents. However, as of October 2000 a new DOC policy outlining the use of brodifacoum (and other second-generation anticoagulants) on public conservation land came into force. Essentially, the policy stated that brodifacoum could not be used where deer and pigs are present because of the risk of human consumption of possibly contaminated game meat (DOC 2000). This is because brodifacoum is persistent and will accumulate in the tissue of sub-lethally poisoned animals (Eason 1999). This policy has serious implications for the way DOC staff manage rodents (ship rats (*Rattus rattus*), Norway rats (*R. norvegicus*) and house mice (*Mus musculus*)) and possums (*Trichosurus vulpecula*) at many sites around New Zealand. Fortunately, the problems of non-target brodifacoum contamination of game meat and some threatened species were recognised by staff at the 'mainland island' sites much earlier than October 2000. The issue was a major topic of discussion at the 1998 annual 'mainland island' hui held at Tutira (Cranwell 1998) and there was general acknowledgement by the attendees that using brodifacoum for ongoing rodent control, whilst very effective, was probably unsustainable in the long term. Following the 1998 hui, staff at most of the DOC 'mainland island' sites began investigating alternative techniques for controlling rodents.

At a recent (June 2001) beech forest ecosystem management workshop (attended largely by staff involved with mohoua (*Mohoua ochrocephala*) management), several people made the comment that DOC staff 'still don't know how to manage rats on the New Zealand mainland'. The impression that rats are essentially unmanageable indicates that some of the lessons being learnt at the DOC 'mainland islands' have yet to be disseminated to staff in the department as a whole. Therefore, the purpose of the rodent control workshop session at the 'mainland island' hui held at Omapere in August 2001 was to:

- Review the different rodent control techniques tried at the 'mainland islands' in the last few years and list the relative advantages and disadvantages of each technique.
- Produce a list of some of the pre-planning issues that need to be considered when managing rodents (and when considering a particular technique).
- Highlight some of the research questions that need addressing.
- Put forward some suggestions for how the lessons learnt about rodent control at 'mainland islands' should be disseminated.

As a background to this session, two weeks prior to the 2001 'mainland island' hui a questionnaire was sent out to staff at the DOC 'mainland islands' (and some other sites where rodents were being controlled) requesting details of the different rodent control techniques they had used. The questionnaire requested:

- Details of advantages and/or disadvantages of techniques tried at those sites
- Some estimated costs of each technique
- Information on the results and outcomes of each technique tried.

This paper is a summary of the combined responses from four 'break-out groups' set up for the 2001 hui rodent control workshop session and the responses to the pre-hui rodent control questionnaire. I have supplemented the summary of the pre-hui questionnaire responses with details from relevant annual reports where these are appropriate or available.

2. Advantages and disadvantages of current techniques for controlling rodents

The responses from the questionnaire and the four workshop 'break-out groups' indicated that there are a range of techniques currently being used for controlling rodents on the New Zealand mainland and these fall into two broad categories—trapping and toxins.

2.1 TRAPPING

2.1.1 Pre-hui questionnaire—trapping to control rats

Technical staff from five of the six official DOC 'mainland islands' and a rodent control operation at Kaiaraara on Great Barrier Island completed pre-hui questionnaires. Kill-trapping of rats has been carried out at four of these sites using either Victor professional rat traps (Woodstream Corporation, Lititz, U.S.A.) set under coreflute covers, or double Mk IV Fenn trap (FHT Works, Worcester, U.K.) sets in wooden tunnels. The traps were baited with peanut butter or, in some cases, chocolate buttons. Trap spacing varied between those sites that used them, as did the frequency of checking and the techniques used to monitor the results.

The results from the pre-hui questionnaire indicated that the density of traps could influence the likelihood of successfully reducing rodents to target indices. At Kaiaraara on Great Barrier Island and in the Northern Te Urewera (except for internal lines in the Otamatuna core area, where traps were set at 50 m spacings), snap traps were spaced at 25-m intervals along lines 75–150 m apart. Staff from both these sites reported that even when rat numbers were apparently very high, target indices (< 5% mean number of tracking tunnels tracked by rats) could be obtained (Table 1). At Rotoiti, snap traps were set at a lower density (100 m × 100 m on lower slopes and 150 m × 100 m on upper ridge sections) over 825 ha. This effort was not able to reduce rats to below 5% tracking indices; however, the trapping followed the biggest beech (*Nothofagus* spp.) mast-seeding event recorded in 30 years (Waddell & Butler 2001). Nevertheless, rat abundance in the trapped area at Rotoiti was reduced to less than 10% mean rat tracking rate (Table 1), which was low enough to significantly reduce robin (*Petroica australis*) mortality compared with that at the nearby non-treatment site. The only trapping operation that apparently failed to reduce rat numbers to target levels was at Hurunui, where snap trap indices for rats were not consistently reduced to much less than about 5 rats per 100 corrected trap nights (Nelson & Clark 1973) at best (A. Grant, DOC Canterbury Conservancy, pers. comm.). Hurunui 'mainland island' is a steep-sided valley system about 18 km long (Grant et al. 1999) and the area over which rats were targeted, reported in the pre-hui questionnaire, was about 6000 ha (Table 1). The trapping density there was low compared to Kaiaraara, Northern Te Urewera and Rotoiti. There were 260 Fenn trap sets, set to target both mustelids and rats, placed at 100-m spacings, but only in a line along the bush edge on both sides of the valley floor. The trapping results indicate that a line of widely spaced traps along the valley floor alone is insufficient to control rats (when they are very abundant following beech mast events) to very low numbers over the entire valley system. It is also possible that targeting mustelids as well as rats with the same traps reduced control efficiency for the rats.

2.1.2 Advantages of trapping

The most commonly reported advantage of kill-trapping rodents was that it is much more acceptable to the public than use of toxins. Trapping has other advantages in that it can allow greater community involvement in pest control projects and can provide paid work for some local people. These opportunities are generally not available with poisoning, which often has to be carried out by trained professionals. Other reported advantages of trapping were that it has few detrimental environmental effects, with no off-site impacts or toxins to be disposed of following the operation. The results and conservation outcomes have shown that trapping is a very effective means of controlling rats (Table 1). As a bonus, mustelids are often caught as a by-catch in rat traps; and at some sites the trapped rats provide an 'end-use product', if dead rats recovered in good condition are freeze-dried and subsequently used as lures in Fenn traps set to control stoats (and other mustelids). Trapping can also be used to investigate aspects of the rodent biology and ecology, such as weight, diet sex ratios etc. The results of trapping operations are easy to interpret because the exact numbers of rodents caught, traps sprung and non-targets killed are known, which is not the case with poisoned animals that may be hidden when they die. Capture rates can also be a useful adjunct to other measures such as tracking tunnels, for indicating rodent population trends. Traps can be purposefully set to allow estimation of rodent densities. One group also reported that traps have a curiosity value that is not tied to food availability. In other words, the rat only has to investigate a trap to be killed, whereas it has to eat a toxic bait to receive a lethal dose of poison.

TABLE 1. RODENT CONTROL METHODS AND THE EFFECTIVENESS OF EACH AT CONTROLLING RATS (EXPRESSED AS MEAN PERCENTAGE OF TRACKING TUNNELS TRACKED BY RATS, EXCEPT FOR THE HURUNUI, WHERE THE RESULTS ARE EXPRESSED AS NO. OF RATS CAUGHT PER 100 CORRECTED TRAP NIGHTS.

SITE NAME	AREA CONTROLLED	BRODIFACOUM CEREAL AND WAXED BAITS, CINNAMON LURED	1080 CEREAL BAITS	AERIALLY SOWN 1080 CEREAL BAITS	WARFARIN, CEREAL BAITS, CHOCOLATE LURED	WARFARIN, CEREAL BAITS, NON-LURED	WARFARIN, PEANUT PASTE, CHOCOLATE LURED	SYNERGISED WARFARIN, PEANUT BASED AND LURED PASTE	SYNERGISED WARFARIN RICE BASED NON-LURED PASTE	PINDONE	FERACOL, PEANUT PASTE	VICTOR PROFESSIONAL SNAP TRAP	DOUBLE MKIV FENN TRAPS IN A LINE ALONG VALLEY FLOOR
Trounson	450 ha	reliable < 5%	reliable < 5%	-	mixed < 5%	-	mixed < 5%	mixed c. 5%	mixed c. 5%	-	mixed < 5%	-	-
Northern Te Urewera	1400 ha (1) = 800 ha (2) = 1000 ha	(1) reliable < 5%	-	-	-	-	-	-	-	(2) mixed < 5%	-	reliable < 5%	-
Boundary Stream	800 ha	reliable < 5%	-	mixed < 10%	-	failed > 25%	-	-	-	reliable < 5%	reliable < 5%	-	-
Rotoiti	825 ha	mixed < 5-11%	reliable < 5%	-	-	-	-	-	-	-	-	mixed < 10%*	-
Hurunui	6000 ha	-	-	-	-	-	-	-	-	-	-	-	failed c. 5 rats 100CTN
Kaiaraara, Great Barrier Island	100 ha	-	-	-	-	-	-	-	-	-	-	mixed < 5%	-

Note: Reliable = operators reported that the method consistently achieved the mean % tracking rate listed. Mixed = operators reported that method could achieve the mean tracking rates listed but sometimes had to apply repeat doses or the rat indices were fluctuating as a results of seasonal or cyclic events (e.g. beech mast). Failed = operators reported that the method failed to reduce rodent numbers to or below the required index target.
* = Robin breeding significantly higher at this site relative to associated non-treatment reference area.

2.1.3 Disadvantages of trapping

The two most commonly reported disadvantages of trapping were that it is quite labour-intensive (which can increase costs, see Appendix 1) and that it can have animal welfare implications, particularly if traps are not inspected daily. Other potential disadvantages reported were that the effectiveness of traps may be habitat-specific and that they are subject to non-target interference (particularly mice in some areas). The traps used at present are only single-kill devices, so that once they are sprung they no longer kill rats until they are reset. There are also undesirable non-target impacts (e.g. robins which can occasionally get caught) and baits often degrade between trap checks, particularly as a result of scavenging by insects. Another disadvantage of trapping is that re-setting traps involves handling dead rats which can expose people to diseases such as leptospirosis.

2.2 TOXINS

2.2.1 Pre-hui questionnaire—controlling rats with toxins

At four of the five 'mainland island' sites reported on in the pre-hui questionnaire, toxins have been used, or are being used, to control rodents (Table 1). There is currently a range of toxins, other than the second-generation anticoagulant brodifacoum, available for rodent (or, at least, rat) control. These include the first-generation anticoagulants warfarin, synergised warfarin and pindone; and two acute poisons, 1080 (sodium monoflouroacetate) and cholecalciferol. The most commonly reported way of delivering these toxins was in bait placed in bait stations set in a grid pattern about the managed area.

Brodifacoum, in either 'Talon® 20P' baits (ICI Crop Care, Nelson, New Zealand) or 'Pest Off' baits (Animal Control Products, Wanganui, New Zealand), has been used at some time to control rodents and possums at Trounson, Northern Te Urewera (Otamatuna core area), Boundary Stream and Rotoiti. 'Philproof Feeder' bait stations (Philproof, Pest Control Products, Hamilton, New Zealand) were used at all of these sites and were set on grids ranging from 100 m × 100 m to 100 m × 150 m. The baits were available in stations year-round at Trounson (replaced approximately every 2 months), Boundary Stream (replaced every 4–12 weeks) and Rotoiti (replaced approximately every 6 weeks). In Northern Te Urewera, brodifacoum baits were only used to reduce rat numbers over the spring-summer breeding seasons of kokako (*Callaeas cinerea*) and robin (Shaw & Beaven 1998; Shaw 2000). Brodifacoum was generally very effective at reducing rats to below target indices of less than 5% mean number of tracking tunnels tracked by rats (Table 1). The only site where this target was not consistently achieved was Rotoiti when rat numbers increased dramatically following two consecutive beech mast events.

1080 was aerially sown for possums (with rodents as an incidental target species) at Boundary Stream in May 1996, but the operation only had a limited effect on rodent abundance (McRitchie 2000). 1080 in bait stations was used for the initial reduction of rodent and possum populations at the commencement of pest management operations at Trounson in June 1996 and at Rotoiti in October 1997. At Trounson, the initial operation reduced rats and mice to very low levels (Gillies & Pierce 1999); at Rotoiti, however, rodents were at such low levels prior to the 1080 operation that it was difficult to determine effects on these pests (Butler 2000). Another 1080 operation targeting rodents and possums was undertaken at Trounson in November 1998 which successfully reduced rat and mouse numbers (Leach 2000). Prior to that operation, c. 450 additional 'Philproof Feeder' bait stations, modified to allow only mice to feed on the baits, were installed in the 450 ha park, increasing station density to c. 2 per ha on a 50 m × 100 m grid (Coad 1999).

Attempts at controlling rodents using the first generation anticoagulant warfarin (500 ppm) in cereal baits (Animal Control Products, Wanganui, New Zealand) loaded in bait stations at Trounson and Boundary Stream met with limited success (Table 1). At Trounson the initial attempts at using this toxin successfully controlled rats and mice (Coad 1999); however, repeat doses in the summer of 1999/2000 suppressed rodent numbers only for short periods (Leach 2000). The trial at Boundary Stream resulted in a small reduction in rat indices, but was generally inconclusive (Cranwell 2000). Operators at Boundary Stream believe that bait interference by possums, an abundance of alternative foods, and high rat densities may have contributed to this inconclusive result. Subsequent trials at Trounson using warfarin (500 ppm) in a chocolate-lured peanut paste (Animal Control Products, Wanganui, New Zealand) were successful at reducing rat numbers initially, but repeat doses in the summer of 2000/01 could not keep rat numbers suppressed. It was difficult to discern any effect of the warfarin peanut paste on mice at Trounson because numbers of mice were also low at the nearby non-treatment site. Attempts at controlling rodents at Trounson using synergised warfarin (250 ppm, Feral control, Auckland, New Zealand) in a peanut-based and lured paste and a rice-based unlured paste met with limited success for rats and did not appear to have much of an effect at all on mice. Operators at Trounson believe that differences in seasonal bait acceptance by rodents, particularly of the cereal-based baits, may account for the variable results.

Pindone (0.5 g/kg, Pest Management Services Ltd, Waikanae, New Zealand) was used continuously (with baits replenished every 8 weeks inside the reserve and every 4 weeks on the margins) in bait stations at Boundary Stream from October 2000 until May 2001 for rodent control. Staff there reported that the Pindone operation successfully suppressed rats to low levels throughout the entire period that baits were in the stations. Pindone was also used successfully to reduce rat numbers to target tracking indices over the 1998/99 spring-summer breeding season of kokako and robin in Northern Te Urewera (Shaw 2000). However, during the 1999/2000 spring-summer season in the Northern Te Urewera, repeat doses of Pindone failed to reduce rats to the target indices in the Mangaone block (200 ha on c. 5 km of main ridge, with bait stations every 50 m along the ridge and along sidle lines 150 either side of ridge crest) and only gradually did so by January in the 850 ha Otamatuna block (Burns et al. 2000).

A trial of FeraCol® paste (0.1% Cholecalciferol, Feral control, Auckland, New Zealand) used in bait stations (100 g per station) to control rodents was carried out at Boundary Stream between June and August 2000. Staff at Boundary Stream reported that FeraCol® paste was effective at controlling rats to below 5% mean tracking rate in tracking tunnels but the field life of the bait formulation was short and would need to be improved for it to be cost-effective.

FeraCol® paste (0.65% Cholecalciferol) was trialled at Trounson in the autumn of 2000 and although rat (and, to a lesser degree, mice) numbers were reduced to close to target indices, the trials were inconclusive. Operators at both Trounson and Boundary Stream reported in the questionnaire that FeraCol® warrants further investigation as a rodenticide.

2.2.2 Advantages of using toxins

The most commonly reported advantage of toxins was that they are less labour-intensive to use than trapping. Other advantages were that many toxins can have secondary kills of other mammalian predators (cats and mustelids), can be used over large areas and can control multiple species (possums and rats).

2.2.3 Advantages of specific toxins

1080 (sodium monofluoroacetate) This toxin kills target animals rapidly and, in some circumstances, can achieve excellent kills of rodents (especially when used in bait stations) along with good secondary kills of other mammalian predators. Very large areas can be treated relatively cheaply and a range of species can be targeted with one application when the 1080 baits are sown aerially. 1080 breaks down quickly in the environment, is water-soluble and available in a range of forms.

Pindone (0.5 g/kg possum pellets) The costs of using pindone were reported to be similar to those for brodifacoum because both possums and rodents can be targeted in the same operation. It can be effective at maintaining low rodent densities, although not necessarily during years of very high rat abundance. Pindone (and other first-generation anticoagulants) do not persist as long in mammalian liver tissue as second-generation anticoagulants.

FeraCol® (Cholecalciferol) paste Only small quantities of bait are required (relative to anticoagulants) and the toxin has a relatively lower toxicity to birds (compared with other toxins). Another reported advantage was that cholecalciferol breaks down easily in the environment as it is probably degraded by sunlight.

2.2.4 Disadvantages of using toxins

The two most commonly reported disadvantages with toxins were the risks of non-target kills and that the use of toxins is not accepted by some local people or hunters in many areas. Other reported disadvantages include possible development of resistance to toxins in rodents, the possible risks of persistence of toxins in the environment and the impacts of adverse weather on the effectiveness of individual operations. The results of a toxin operation are not as transparent as those from trapping operations. The numbers of rodents killed can only be extrapolated from result monitoring using indices of relative abundance and/or the amount of bait taken from stations. The non-target effects of toxin operations are usually hard to determine and are often only discovered opportunistically. Another important disadvantage with toxins is that most have only been licensed for use against a few specific pests and using them for non-licensed pests requires an experimental use permit (EUP) and subsequent costly registration fees. There are fewer opportunities for community involvement in pest control projects with toxins because these often have to be carried out by trained professionals. General worker health and potential changes in government policy were also reported as important disadvantages of toxin use.

2.2.5 Disadvantages of specific toxins

1080 This toxin generally has 'bad press' which often leads to significant problems with operational planning. Non-target impacts, such as 'the neighbour's dog' can strain community relations. There is a large amount of paperwork associated with operations using 1080, especially the assessment of environmental effects (AEE) consent process (although this process is not restricted to just 1080). The risk of pest populations developing bait shyness (aversion) means that despite its being able to achieve excellent results controlling rodents, 1080 cannot be used regularly for maintaining them at low densities. Pre-feeding before bait station operations can also increase labour costs.

Pindone One of the main problems expressed for pindone was that it is not currently registered for use against rodents and is only available for use under an EUP. Another disadvantage expressed was that it is not as toxic as brodifacoum.

Warfarin (and synergised warfarin) At two sites where warfarin has been used either in Wanganui No. 7 cereal baits or peanut paste, results were not very encouraging and it was, at best, only seasonally effective (Table 1). Poor bait acceptance in some seasons (when alternative natural food sources may be abundant) and low bait availability (due to competition with possums) were suggested as possible reasons for the variable success of this toxin for controlling rodents. Other disadvantages mentioned for warfarin were that the necessity to pre-feed before the poisoning operation and to remove any uneaten toxic baits at the end of the operation can increase costs (Appendix 2). Also, the cereal baits seem to be 'more crumbly' than those used for brodifacoum. Another concern expressed was that rodent resistance to warfarin has been reported in the literature and resistance could limit its use somewhat for sustained rodent control in New Zealand.

FeraCol® paste The disadvantages reported for FeraCol® paste were that it is expensive and may have a short field life. The trials that have been done were completed under an EUP, as cholecalciferol is currently not registered for rodents. However, it was mentioned that the cost is offset somewhat by having to use less bait than for other toxins. Although bait longevity appears to be an issue with cholecalciferol, this toxin warrants further investigation as a rodenticide.

3. Pre-planning issues to consider

The four 'break-out groups' highlighted a range of issues that should be considered prior to commencing a rodent control operation and I have attempted to summarise these into some broad common categories. These issues are ordered based upon how I perceived the importance of each when compiling the session flip charts.

1. Prior to commencing control work, operational objectives need to be clearly defined. Why do you want to control rodents (rats and/or mice)? If the operational objectives are explicit then it will be much easier to address the other pre-planning issues that were highlighted by the groups.
2. How long do you need to control rodents? Do rodents need to be suppressed to low densities year-round, or is the operation only to be a pulse through a particular season or specific timeframe (e.g. robin breeding season)? If the plan is control rodents over the long term (i.e. year-round) then consideration should be given to:
   - Using a variety of methods.
   - The potential for development of resistance to toxins and/or trap shyness in animals.
   - Environmental implications of ongoing rodent control, particularly using toxins.
   - Environmental fluctuations that could affect the efficacy of a particular method (e.g. beech mast events). If rodent numbers are particularly high, a more concentrated density of traps or more toxic baits may have to be used in order to reduce the numbers to required target abundances quickly—this is particularly important for protection of species that are especially vulnerable to rat predation short-term (e.g. robins during the breeding season).
3. Non-target species. Both trapping and the toxins presently available for rodent control have potential effects on non-target species that need to be identified at the pre-planning stage. Non-target issues that the 'break-out groups' reported as needing to be considered include:
   - The risks of any negative impacts on native species and whether or not the timing of the operation or the choice of toxin can mitigate these.
   - Whether trap covers and/or specific features of bait station design are required to reduce or prevent trap or bait interference by non-target species.
   - Whether any secondary poisoning of cats or mustelids may occur and what the benefits of this would be.
4. Monitoring. What outcome and operational result monitoring will need to be done? Will some pre-control monitoring be required to establish baseline measures of either rodent abundance or the values that are expected to benefit from the control work? Will monitoring be required for any non-target effects, particularly if toxins are to be used?
5. Who will do the work? Are there sufficient resources available to conduct the operation within the planned timeframes? This is particularly important for

trapping, which requires a greater labour input than poisoning. Community involvement should be considered. Trapping could provide an excellent opportunity for providing employment for local people.

6. Legal requirements. Sufficient time should be allowed to complete the consents and AEE process, particularly if the plan is to use toxins—there may be public acceptance issues to be dealt with.
7. Other pests. The presence of other pests can have an effect on the efficacy of some control methods. If possums are present, they are likely to consume some toxic bait, thereby reducing its availability to rodents. Such interference can significantly reduce the efficiency of a trapping operation. In circumstances where possum interference or competition is likely to be a problem, controlling these pests will need to be considered during planning.
8. Issues specifically related to trapping:
   - Attractiveness and longevity of bait, which can influence the frequency of trap checking.
   - Trap spacing, layout and the possibility that a high (trap) density buffer zone could be required around the operational area to limit reinvasion.
   - Providing the labour required to ensure that sufficient tracks can be put in to service the trap network (largely a set-up rather than on-going cost).

4. Research requirements

The 'break-out groups' reported quite a few areas where our knowledge is currently lacking. I have put these in descending order, with the most commonly expressed research requirements first.

- What are the impacts of mice on lower trophic levels in an ecosystem?
- What is the nature of the interactions between rodent species (particularly rats and mice) and what are the management and food web implications for mice when rat numbers are suppressed?
- How can mice be controlled cost-effectively, particularly when rats are being suppressed to low densities at a site?
- Can baits be improved? In particular, can long-life baits suitable for use in traps and new (highly palatable and long-lasting) bait formulations be developed?
- What are the minimum areas that rodents must be controlled over, that will still provide benefits for native species? Can a 'rolling front' approach be applied to rodent control on the mainland and how important is buffer zone control at a site?
- Can new rodent control techniques be developed? Areas that need investigation include developing multi-pest traps, biocontrol technologies, and enhancing the effectiveness of those toxins currently available for use.
- What are the optimum checking frequencies and trap spacings for rat control operations?
- Can beech seed mast events be better understood and predicted?

- Can mice (and other rodents) be cost-effectively controlled to low enough densities and over sufficient area to prevent a (localised) stoat irruption following beech-masting events?
- What are the implications of losing the benefits of any incidental secondary poisoning of mustelids and cats when switching from controlling rodents using toxins to using traps?

5. Information requirements

The final objective of the 2001 hui rodent control workshop session was to assess how DOC could improve communication of rodent control information within DOC and the wider community. The following suggestions were made:

1. That an e-mail list of important rodent control people within and outside DOC be created on the DOC Intranet.
2. That a DOC staff member be appointed as a national co-ordinator of rodent control issues.
3. That a specialist rodent group and/or web page be set up to provide advice and co-ordinate rodent control issues nationally within DOC.
4. That rodent control technologies developed, tested or improved at DOC 'mainland islands' be communicated to the public and to community organisations that are likely to benefit from this information.

6. Conclusions

Currently there are two main options available to DOC staff for rodent control on the New Zealand mainland—kill-trapping and toxins. The main advantage of kill-trapping is that generally the technique has a much greater public acceptance over toxins. Results from those sites that have used traps to control rats indicate that traps need to be set on 25–50 m × 75–150 m grids over the operational area in order to achieve results similar to those that could be expected if brodifacoum was used. Toxins are generally less labour-intensive than kill-trapping and rodents can be controlled over relatively larger areas. However, problems with persistence in non-target species mean that brodifacoum and other second-generation anticoagulants are generally no longer available to DOC for rodent control on the mainland. Results from those sites that have tested alternative toxins to brodifacoum are variable. 1080 in bait stations was reported to be a reliable alternative to brodifacoum but cannot be used as frequently. The first-generation anticoagulants warfarin and pindone, and FeraCol® paste (cholecalciferol) have been used to control rats at several of the 'mainland islands'. In some instances these toxins were not as consistent at reducing rat abundance to levels routinely achieved using brodifacoum. Most of the alternatives to brodifacoum for rodent control currently available (both toxins and traps) have proven effective against rats. However, none have proven to be reliably effective against mice (particularly when rat numbers are suppressed) and only pindone (0.5 g/kg) and 1080 can be used to simultaneously target rats and possums. The apparent difficulty in suppressing mouse numbers with these current techniques was an issue raised by all four 'break-out groups' in the hui workshop session. The groups highlighted three common research questions regarding mice: what are the impacts of mice on the ecosystems we are managing? How can we cost-effectively manage mouse populations, particularly when rat numbers are suppressed, and what are the interactions between mice and rats?

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Appendix 1

ESTIMATES OF LABOUR COSTS AND/OR STAFF RESOURCES REQUIRED FOR DIFFERENT RODENT CONTROL ACTIVITIES FROM FIVE 'MAINLAND ISLAND' SITES AND ONE OTHER (AS AT SEPTEMBER 2001)

NOTE: THESE ESTIMATES DO NOT INCLUDE SET UP COSTS, FOR THESE SEE APPENDIX 2.

SITE	ACTIVITY	ESTIMATED LABOUR COSTS OR STAFF RESOURCES
Trounson	One fill of 500 bait stations over 450 ha	$1,000.00
Boundary Stream	One pulse of toxin in 575 bait stations over 800 ha	14 staff days per pulse
	AEE (and associated activity) preparation per toxin	5–10 staff days
	Bait station line maintenance	10 staff days per year
Northern Te Urewera	Eight trap checks (at 5-weekly intervals) over 800 ha. Year-round control	$13,600 per year for contract labour
Rotoiti	Eight services of brodifacoum bait stations over 825 ha	80 staff days per year
	Bait preparation, AEE and data entry for brodifacoum operation	20 staff days per year
	Nineteen trap checks over 825 ha (in years rat numbers are exceptionally high)	150 staff days per year
	Ten trap checks over 825 ha (in years when rat numbers are normal)	80–100 staff days per year
	Data entry etc. for trapping operation	20 staff days per year
Hurunui	One person servicing the valley floor trap lines for 3 months (6 × 10 days), 6000 ha in total	$5,760.00
Kaiaraara, Great Barrier Island	Service traps over 6 months on 100 ha study site	$12,000

Appendix 2

ESTIMATES OF ADDITIONAL EXPENSES FOR DIFFERENT RODENT CONTROL ACTIVITIES FROM FIVE 'MAINLAND ISLAND' SITES AND ONE OTHER (AS AT SEPTEMBER 2001)

SITE	TYPE OF EXPENSE	COST
Trounson 450 ha,	25 kg 1080 0.15% No. 7 cereal baits	$59.95
c. 950 bait stations on	25 kg prefeed No. 7 cereal baits	$44.95
50 m × 100 m grid	Pest off brodifacoum 250 kg per pulse	$1375.00 per pulse
	Warfarin paste 100 kg per pulse	$930.00 per pulse
	Warfarin No. 7 cereal baits 200 kg per pulse	$650.00 per pulse
Boundary stream 800 ha,	Equipment (packs, signs, markers, safety and miscellaneous items)	$200.00 per year
575 bait stations on	Brodifacoum 150 kg per pulse	$3000.00 average per year
150 m × 150 m grid	Pindone 150 kg per pulse	$3000.00 average per year
	FeraCol 60 kg per pulse	$2400.00
	Waste bait disposal	$100.00 average per year
	Staff poison allowance, 846 hrs	$345.00 per year
	Vehicles (2 × quads) maintenance	$1000.00 per year
Rotoiti 825 ha	Purchase 706 Philproof bait stations	$12,000.00
	710 kg of Talon brodifacoum bait	$2485.00 per year
	Purchase 707 Victor rat traps	$3,710.00
	Purchase trap covers and bases etc.	$1,000.00
	Replacement trap trigger pedal	$50.00 per year
	Peanut butter and rolled oats bait	$120.00 per year
Hurunui, 6000 ha	Purchase materials, traps and bait for 260 stations	$10,486.50
Kaiaraara 100 ha	Purchase 450 Victor traps	$2,500.00
	Purchase bait for traps	$500.00
	Contract staff to set up traps and cut tracks	$5,000.00