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ERADICATION OF KIORE (*Rattus exulans*) FROM DOUBLE ISLAND, MERCURY GROUP IN NORTHERN NEW ZEALAND

by

Ian McFadden

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CONTENTS

ABSTRACT	**1**
1. INTRODUCTION	**1**
2. STUDY AREA	**2**
3. METHODS	**4**
4. RESULTS	**5**
5. DISCUSSION	**6**
6. CONCLUSIONS	**8**
7. ACKNOWLEDGEMENTS	**11**
8. REFERENCES	**11**

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Ian McFadden
Department of Conservation, Private Bag 68908
Auckland, New Zealand

ABSTRACT

Kiore were eradicated on Double Island using two different methods. The larger islet was treated with one manual application of STORM 4 g wax block rat baits containing 0.005% by weight Flocoumafen, in October 1989. The smaller islet received one application of toxic kibbled maize (0.005% bromodialone by weight) after 4 nights pre-feeding in November 1989. Kibbled maize was dispensed in silos. No sign of kiore has since been found during four visits to both islands. The cost per hectare for both methods were quite comparable. The nett cost for eradication on the larger islet (19 ha) was $310/ha, the smaller islet cost $432/ha. Both methods are considerably cheaper than the technique used to eradicate Norway rats (*R. norvegicus*) from Hawea Island. For future rodent eradication campaigns it is suggested that aerial applications of poisons may be made on all islands greater than 50 ha, and that size should be no barrier to rodent eradication. However, substantial non-target have been recorded when 1080 baits were broadcast aerially to control possum. Non-target kills of a similar magnitude may be experienced on larger and more sensitive islands.

1. INTRODUCTION

Kiore or Polynesian rats (*Rattus exulans*) may have arrived in New Zealand 1000 years ago, about the time of colonisation by Polynesians (Davidson 1984). Since that time they have variously affected the flora and fauna and are now considered by conservation agencies to be a nuisance on some offshore islands.

Attempts have been made to eradicate rats from offshore islands using bait stations, however the presentation of baits within stations will not prevent non-target species gaining access to them. On Somes Island, in Wellington Harbour, wax block rat baits were laid for ship rat (*R. rattus*) in PVC pipes and large plastic containers. Black-back gull (*Larus dominicanus*) and house sparrow (*Passer dom. domesticus*) readily entered both types of bait station and either removed, or fed on, baits (I. McFadden pers. obs.). On Tawhitinui Island, Tennyson inlet in Marlborough Sounds, weka (*Gallirallus australis*) removed baits from novacoil bait stations (Taylor 1984). On Breaksea Island kea (*Nestor notabilis*) took bait from novacoil stations (Taylor and Thomas in press). On Rurima Rocks house sparrows soon that silos contained food, and on Korapuki Island red-crowned parakeet (*Cyanoramphus novaezelandiae*) quickly learned that a meal could be obtained from the silos. Towards the end of the Korapuki campaign parakeets followed operators around the island as bait stations were replenished. Campaigns using permanent bait stations successfully eradicated rats from Rurima Rocks and Korapuki Island (McFadden and Towns 1991) but this is a labour- intensive method and the cost per hectare is high. In some instances it may be advisable to use this method when endangered species are at risk.

To reduce the risk of birds taking baits, wax block rat baits are dyed green (Talon and or blue (Storm) (Caithness and Williams 1971, Brunner and Colman 1983). Trials conducted at Karioi Forest showed clearly that green-dyed carrot or pollard baits killed less non-target birds than undyed baits (see Newman in Rammell and Fleming 1978).

If dyed baits could be broadcast uniformly and economically then it may be possible to eradicate kiore on quite large islands (e.g. Codfish, c.1300 ha) which would add enormously to their conservation potential/value.

This report provides details of an eradication campaign against kiore on Double Island, in the Mercury Group, using two different methods: pre-feeding at grid-based bait stations, and direct broadcasting of poison pellets by hand. A cost analysis allowed a comparison to be made between the two methods.

2. STUDY AREA

Double Island (grid ref. NZMS 1, N40/340880) lies within the Mercury Group off the east coast of Coromandel, 13.6 km northeast of Opito Bay (Fig. 1). The island consists of two islets joined at low tide by a boulder isthmus (Fig. 2). The larger (19 ha) rises to 108 m a.s.l. and has vertical cliffs along the northern side, elsewhere the shoreline is lined with large, well-rounded boulders. The islet rises uniformly to a central plateau with a large terrace at the eastern corner. The forest canopy consists of red mapou (*Myrsine australis*), mahoe (*Melicytus ramiflorus*), with emergent pohutukawa (*Metrosideros excelsa*). A high bench at the NW corner is dominated by tawapou (*Planchonella costata*). The ground surface is mainly bare with highly mobile topsoil, disturbed by burrowing seabirds. In winter grey-faced petrel (*Pterodroma macroptera gouldi*), diving petrel (*Pelecanoides urinatrix*) and fluttering shearwater (*Puffinus gavia*) breed in good numbers with grey-faced petrels being the most common. Over summer low numbers of sooty shearwater (*P. griseus*), flesh-footed shearwater (*P. carneipes*), and the rare Pycroft petrel (*P. pycrofti*) breed.

By contrast, the smaller islet (8 ha) rises to 87 m a.s.l. and has a varied vegetation. On the summit plateau ground cover is dominated by *Astelia banksii,* and the canopy by houpara *(Pseudopanax lessonii),* kohekohe *(Dysoxylum spectabile),* with a few emergent pohutukawa. Along the northern slopes vegetation is similar to the large islet and the entire shoreline is made up of large angular boulders. The southern side is

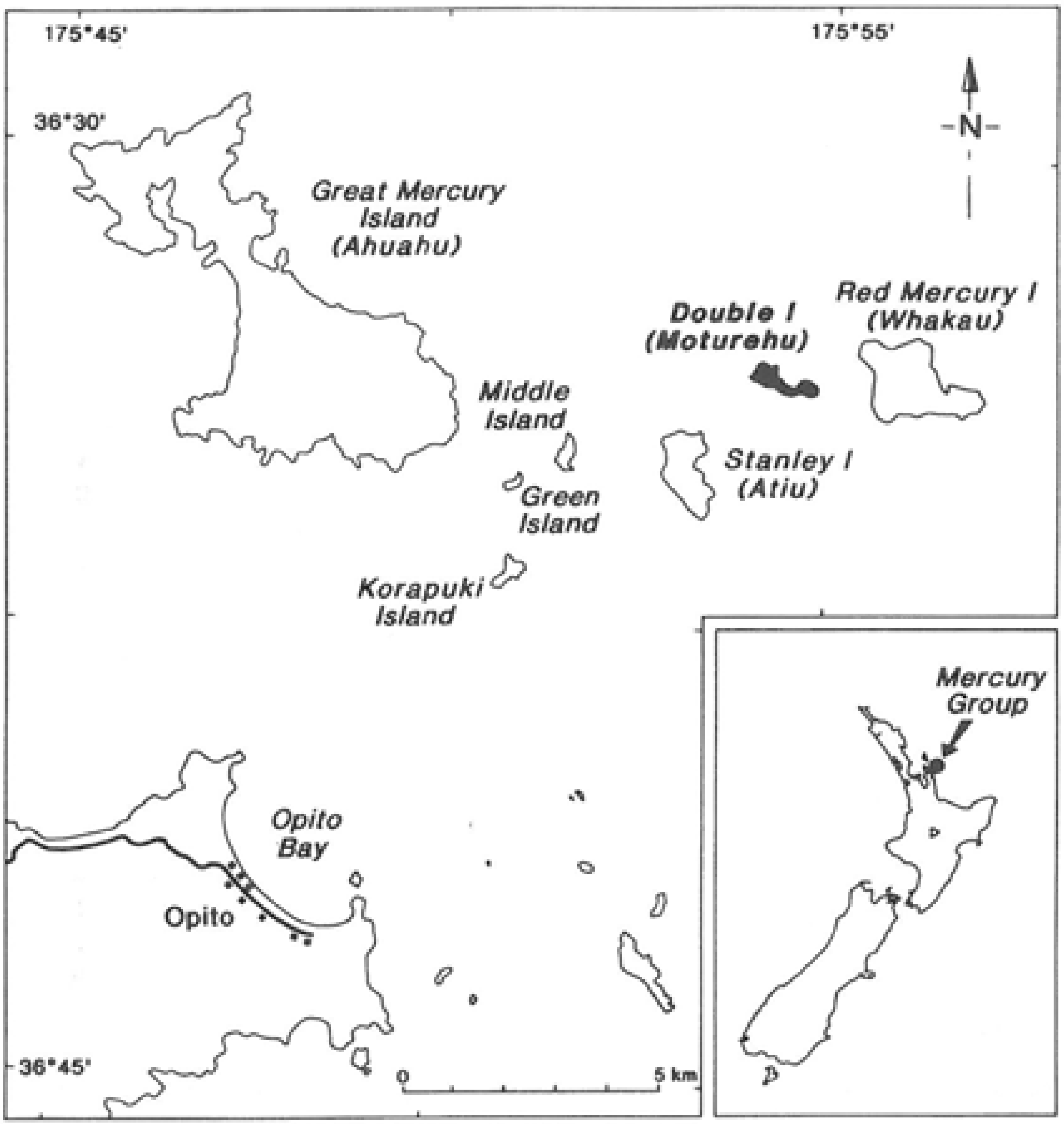

Fig. 1 Double Island, in the Mercury Group, is located off the east coast of the Coromandel Peninsula [inset].

dominated by a mature forest of karaka (*Corynocarpus laevigatus*), kohekohe, and tawapou with one puriri (*Vitex lucens*), a few parapara (*Psonia brunoniana*), whau (*Entelea arborescens*) and some large emergent pohutukawa. The same species of ground-nesting sea birds found on the larger islet nest here in similar densities. Both islets have a coastal fringe of flax (*Phormium tenax*), taupata (*Coprosma repens*), kawakawa (*Macropiper excelsum*), coastal mahoe (*M. novae-zelandiae*) and rangiora (*Brachyglottis repanda*).

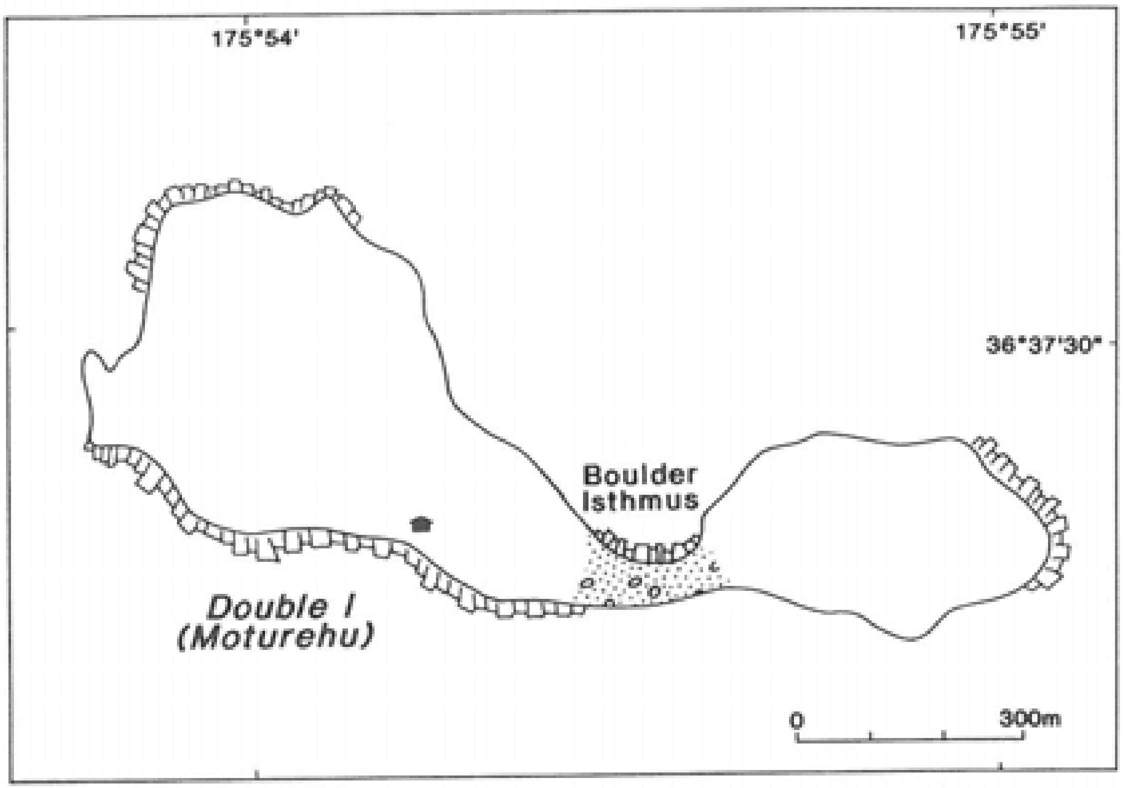

Fig. 2 Double Island.

Kiore were known from both islets and their presence was confirmed by snap trapping in October 1989 (Table 1).

3. METHODS

Method 1

On the smaller islet, 58 silos were placed approximately 50 m apart in a grid pattern and filled with aniseed lured maize pre-feed on 7 November 1989. By 10 November bait was being taken from most silos, and on 11 November all remaining pre-feed was collected. Aniseed lured kibbled maize loaded with 0.005% Bromodialone by weight was then placed into all silos. Silos were next checked on 15 December 1989 when all remaining toxic bait was removed and replaced with coconut lured maize pre-feed. Silos were checked regularly for the next 5 days. No further toxic bait was laid. The next silo check was on 14 January 1990.

Method 2

On the larger islet 350 kg of 4 gram STORM wax pellets were broadcast by hand on 21 and 22 October 1989. Operators spaced themselves 25-30 m apart as they traversed the islet casting baits about. Bait was held in PVC seedling planting bags, and natural features used to divide the island into manageable sections. By mid-day 21 October when half the islet had been baited, rain began to fall, continuing until dark. The remainder of the islet was baited 22 October. Eight operators split into two groups of 4, systematically working around the islet a section at a time. To check bait distribution six grids 10 x 10 m were marked out and pellets counted.

Within 4 weeks of toxic bait being laid, snap trapping was carried out on both islets. Standard supreme rat traps were used, tied onto nearby vegetation. Traps were set at 25 m intervals, either in pairs, one baited with peanut butter, the other with cheese, or singly with baits alternated. Searches were made routinely for rat feeding sign on fruits, or dead birds, and for fresh faecal pellets.

4. RESULTS

Method 1

On the smaller islet bait take was low, but kiore numbers are typically low in November (Moller 1978). Trapping and non toxic baiting between 14 and 20 December failed to detect the presence of kiore. No fresh sign has been seen since November 1989 (Table 1).

Table 1 Trapping effort on Double Island

Date		Trap nights		Catch (kiore)
		Small Is.	Large Is.	
October	1989	60	60	15
November	1989		432	0
December	1989		360	0
January	1990	240	110	0
October	1990	168	384	0
March	1991	288	324	0

Note: Trap nights not corrected for interference. Trap interference caused by seabirds is often high.

Method 2

The eight operators took eight hours to broadcast STORM pellets on the large islet. Pellet counts in the six 10 x 10 m grids yielded an average 63 pellets (range 31-120). The blue baits were easily seen amongst leaf litter. After bait application the entire islet was traversed for areas missed. Pellets were everywhere. On steep slopes distribution was patchy due to pellets tumbling down slopes and being caught amongst accumulations of loose soil and leaf litter on the uphill side of large trees. Overall, bait distribution was acceptable with no areas greater than 100 m^2 without some pellets. Subsequent snap-trapping and searches have failed to locate any sign of kiore persisting.

A morepork nest found in October 1989 was visited daily to look for evidence that it had been abandoned due to adults dying from eating toxic kiore, or that its two chicks had died from being fed toxin-laden kiore. These frequent checks indicated that both chicks fledged. Once empty, the nest contents were examined to determine if the chicks had died in their nest, but only the remains of food items could be identified. No parakeet, morepork, or other species of land bird was found dead throughout the campaign. There are always some dead petrels and shearwaters on these islands. As petrels and shearwaters feed only at sea and come ashore after dark, they would not have been at risk and are assumed to have died from natural causes.

5. DISCUSSION

The original plan for the larger islet was to drop STORM baits from a helicopter using a standard monsoon bucket. Manual distribution was adopted when it became clear the helicopter option would not be available. STORM is the only wax block rat bait available in a size suitable for aerial application. Talon (available in 16 g wax eggs), and Ridrat (35 g wax blocks) are both too large, would break up on impact, and would not feed easily out of a monsoon bucket. STORM contains the second generation anticoagulant Flocoumafen (0.005% by weight) and is available in 4 g wax pellets dyed blue.

STORM proved an effective rodenticide enabling kiore to be eradicated on the large islet with ease. It was convenient to handle, could be distributed easily, and being blue allowed accurate checks for application rate. Conditions on Double Island are not typical of those for which STORM is intended. Sales brochures advertise STORM as containing substances to deter insects, prevent mould, and resist weather. However, the modest rain which fell on 21 October reduced many baits to soggy spots of blue bait. Those baits which did not collapse were soggy outside with a relatively dry core. STORM readily absorbed moisture, and in the humid conditions typical of most northern offshore islands grew a healthy crop of white filamentous fungi which stood up like wispy hair. Bait in exposed places dried out and often appeared to have been eaten by insects (pers. obs.). However, insects were not found dead near baits, and anticoagulants are not known to kill invertebrates. Despite these problems STORM achieved the desired effect.

Our dosage rate of 18.5 kg of STORM per ha was in hindsight an overkill of quite large proportion, however no evidence of non-target kills was detected. The likely result of applying too little bait was having to meet the cost of a second application which would have exceeded the cost of surplus bait used in the first. A more realistic rate may be 2.5-5 kg/ha depending upon rodent densities, terrain, and climate. Moller (1978) recorded a minimum of 11 kiore/ha and a maximum of 96/ha in forest on Tiritiri Matangi Island. In October on Double Island using 4 g STORM baits at 5 kg/ha there would have been 1250 baits/ha, each bait capable of killing 3 kiore. In practice each rat may eat several baits over several days before death, and an excess of bait may have several advantages. Any rat out at night will encounter many baits, the operation takes less time as lethal doses are consumed from day one, and intangibles, like weather, are less likely to affect the success of the operation.

Trials conducted in Australia showed that birds took significantly less grain dyed blue than grain dyed other colours (Brunner and Coman 1983). On Double Island the species most at risk were likely to be red-crowned parakeet (from eating wheat in baits), and from eating kiore, which are a main constituent of their diet on some offshore islands (Saint Girons *et al.* 1986). Kiore which have consumed lethal doses but have not yet died often appear sluggish and easy prey. As moreporks are feeders on live prey, dead kiore are not likely to be a threat. Some species of owl are known to have died by secondary poisoning after eating toxin-laden rodents. Owls held in captivity and fed rodents which had died from eating anticoagulants, either died or displayed symptoms of sublethal haemorrhaging (Mendenhall and Pank 1980). Radio-tagged owls were found dead, or when sacrificed, found to have subcutaneous clots or no other evidence of haemorrhaging after a control operation aimed at voles (*Microtus* spp.) using brodificoum (Merson, *et al.* 1984). Although Flocoumafen was not used in either of these trials it is clear that raptors are vulnerable to secondary poisoning by anticoagulant rodenticides. On Double Island this risk was considered, but the advantage of removing was deemed to outweigh the risk to morepork. Further, morepork occur on nearby islands so they could easily recolonise the island, if the local birds were killed.

Of the six visits made to Double Island, two were to lay poison, and four to follow-up for sign of kiore. This follow-up work is as important as the actual poisoning. A major cost of any eradication campaign is the amount of field work needed to detect and kill the last few animals. Absence of feeding sign at bait stations does not mean that all target animals have been killed. It may simply indicate that they have become bait, or bait station shy. With second generation anticoagulants like Flocoumafen, or bromodialone, bait shyness is unlikely to develop, however, it is dangerous to assume that eradication has been achieved when rodent sign cannot be detected at poison stations. A lengthy period of monitoring is required. The only reliable methods of detection during this phase are snap-trapping, ground searches for fresh sign, and laying passive indicators, such as gnaw sticks, wax candles, and bars of unscented soap. No fixed period can be set for absence of sign before proclaiming an island rodent free, but the longer the period without sign, the more likely it is that eradication has been achieved.

Once eradication has been achieved, permanent bait stations can be established to maintain rat free status. They usually consist of pipe with a number of wax blocks wrapped in aluminium foil, set in them. If operators establish these about sources of likely reinfestation (e.g. wharves) baits missing or chewed foil may indicate rodents. If passive indicators are set they provide additional evidence of reinfestation.

The operation on the larger islet took one full day and employed eight operators. Including labour cost, poison, and one boat charter, the nett cost of eradicating kiore was $309/ha. On the smaller islet if cost of silos, poison, marking out grid and positioning silos, servicing silos, and one boat charter are included, the campaign cost $432/ha. By comparison on Hawea Island (Table 2) where Talon 50WB was used in bait stations in a 40 m grid pattern to eradicate Norway rats (Taylor and Thomas 1989) the campaign cost $1005/ha if the same costs are included without boat charter. If a more realistic application rate is considered (i.e. 2.5-5 kg/ha), cost for manually applying one dose of STORM could be as low as $140/ha. This presents an enormous saving over the laborious job of setting out permanent stations, cutting tracks, and daily servicing for up to three weeks. A full analysis of costs is provided in Table 3.

Table 2 Comparison of some costs for eradicating rats from Double Island and Hawea Island.

Double Island	$(1991)	$ per ha
Small Islet (8 ha)		
Silos and poison	775	
Wages (12 days @ $120/day)	1440	
	2215	or 277/ha
Large Islet (19 ha)		
Poison	3750	
Wages (8 days @ $120/day)	960	
	4710	or 248/ha
Hawea Island (9 ha)		
Poison & bait stations	427	
Wages (27 days @ 120/day)	3240	
	3667	or 407/ha

Note: Only the cost of poison, silos or bait stations, laying bait and wages are considered. Does not include boat charters, field allowances, track cutting or planning.

6. CONCLUSIONS

It appears that kiore were eradicated with one application of STORM on the large islet, and one of kibbled maize loaded with 0.005% bromodialone on the smaller.

Although the operation on the small islet was effective, the success on the larger islet indicates that establishing permanent bait stations may be an unnecessary task. Even for very small islands it may be sufficient to merely broadcast bait manually to eradicate rodents. As mentioned previously, bait stations may not offer the protection to birds that is claimed, and dying baits green or blue may be sufficient to minimise kills of target species. At the excessive application rate used on Double Island non-target kills of any significance would have been noted. At the more realistic application rate suggested (2.5-5 -5 kg/ha), the risk of non-target kills may be reduced.

Provided sufficient bait is made available, the actual method of dispensing may not be important. Anticoagulant rodenticides have been proven effective many times in the field, so it may not matter how many wax blocks each rat eats or caches. When

Table 3 Full costings for eradication of kiore from Double Island.

Both nett[1] and gross[2] costs have been calculated to compare the expense of the two methods chosen.

Nett cost for eradication per islet

Small islet (8 ha)	$	$ per ha
Silos. 55 @ $5	275	
Poison & pre-feed	500	
Salaries @ 120/day	1440	
Field supplies	240	
Boat charter	1000	
	3455	or 432/ha
Large islet (19 ha)		
Poison	3750	
Salaries	960	
Field supplies	160	
Boat charter	1000	
	5870	or 310/ha

Gross cost for eradication per islet

Small islet (8 ha)	$	$ per ha
Silos & poison	775	
Salaries	7200	
Supplies	1440	
Boat charters	5000	
Sundries	500	
	14915	or 1864/ha
Large islet (19 ha)		
Poison	3750	
Salaries	8160	
Supplies	1440	
Boat charters	6000	
Sundries	500	
	19850	or 1045/ha

Continued next page

1 **Nett cost:** The actual cost of setting out silos, pre-feeding, and laying one dose of toxic bait, and one boat charter. Includes salaries , but no follow-up work.

2 **Gross cost:** As for nett, plus follow-up checks, wages and salaries, planning preparation and all associated charges.

Table 3 *Continued.*

Total cost[3] for eradication on both islets compared with Hawea Is.[4]		
Double Is. (27 ha)	$	$ per ha
Poison & silos	4525	
Salaries	8160	
Supplies	1440	
Boat charters	6000	
Sundries	500	
	20625	or 764/ha
Hawea Is.[4] (9 ha)	64000	or 7100/ha

[3] **Total cost:** Combines operations on both islets as they were run concurrently. Costs such as boat charters, salaries, field supplies, and sundries were split between the two islets when they were costed separately.

[4] **Hawea Is. cost:** Costs reported by Taylor and Thomas (1989).

deciding whether to start eradication campaigns, the major factors to consider are level of commitment, cost, and the likely effect on non-target species. Broadcasting baits manually on small islands, or aerially on large, is the most effective and cheapest method of dispensing baits. Aerial applications of 1080 baits in Central North Island forests aimed at the control of brushtail possum (*Trichosurus vulpecula*) have resulted in kills of up to 100% of ship rats (*R. rattus*) (Eason 1991). Aerially sown baits on Mana Island were a major contributing factor in mouse (*Mus musculus*) eradication (T. Hook, pers. comm.). There may need to be some changes to bait composition to make them more durable, particularly Talon 20P, but aerial application of rodenticides makes eradication of all 4 species of rodent found in New Zealand possible. Rodent eradication now looks possible on very large islands. The result of this campaign may give confidence to tackle islands the size of Codfish (1300 ha) or Kapiti (2000 ha).

Broadcasting baits reduces cost significantly and provided baits are dyed green or blue there should be little risk of non-target kills. However, Double Island was chosen because there were few sensitive species present, and those which were thought to be at risk could easily recolonise. Rodent eradication may now be at the stage where possum control was 15 years ago. An effective method has been developed but the effect which broadcasting bait has on the environment is unknown. Substantial kills of birds have been recorded after 1080 drops in North Island forests (Rammell and Fleming 1978). For birds the attractant is the bait, not the toxin. Similar rates of non-target kills are likely to occur from broad scale operations using anticoagulants, and this cost must be considered when deciding which method to use for a rodent eradication attempt.

Each eradication campaign will have to be assessed individually and where some very sensitive species occur extra precautions will have to be taken. Temporary removal, enclosures, or the use of baits which are not palatable to sensitive species at risk are some possible options. On Codfish Island, for example, kakapo (*Strigops habroptilus*) may have to be caught and put into enclosures, or perhaps a lure attractive to kiore, but not to kakapo, could be added to the baits.

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