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USING BRODIFACOUM TO ERADICATE KIORE (*Rattus exulans*) FROM BURGESS ISLAND AND THE KNIGHTS GROUP OF THE MOKOHINAU ISLANDS

by

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CONTENTS

ABSTRACT 1

1. INTRODUCTION 1

2. STUDY AREA 3

3. METHODS 5
 3.1 Poison application 5
 3.2 Rat trapping 5
 3.3 Non-target monitoring 6
 3.4 Monitoring seabirds 6

4 RESULTS 9
 4.1 Poison application 9
 4.2 Rat trapping 9
 4.3 Non-target monitoring 9
 4.4 Monitoring seabirds 10

5. DISCUSSION 12
 5.1 Bait application 12
 5.2 Non-target species 13
 5.3 Cost comparisons 13
 5.4 Conclusions 14

6. ACKNOWLEDGEMENTS 16

7. REFERENCES 17

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ABSTRACT

An attempt to eradicate kiore *Rattus exulans* from Burgess Island and the Knights Group in the Mokohinau Islands was made between August and October 1990. In August, 3 tonnes of Talon' 20 P was broadcast by helicopter from a standard monsoon bucket and 200 kg of Talon® 50 WB was broadcast manually. In October 1990 a further 200 kg of Talon' 50 WB was broadcast manually. Two kiore were snap-trapped within two days of the air drop. Subsequent snap trapping and searches have failed to detect the presence of kiore. Three harrier hawks (*Circus approximans*), two chaffinches (*Fringilla coelebs*), and one song thrush (*Turdus philomelos*) are the non-target vertebrate species known to have been killed. The success of this campaign is a major step forward in developing rodent eradication methods suitable for offshore islands.

1. INTRODUCTION

The Department of Conservation (DoC) was granted funds by Auckland City Council to attempt eradication of kiore (*Rattus exulans*) from the Knights Group in Mokohinau. These islands lie within the extended limits of Auckland City boundary on the outer edge of Hauraki Gulf. This original proposal was to concentrate on the Knights Group (Hunt 1989), but was later revised to include Burgess Island (McFadden 1990). The rationale for this project was the protection of the Mokohinau stag beetle (*Dorcus ithaginus*) and the Mokohinau skink, which is an undescribed species of *Cyclodina*. These species are currently found only on Stack H.

Kiore were introduced by Polynesians at some stage during the past 1000 years (Davidson 1984). Anecdotal evidence strongly suggests that kiore have variously affected New Zealand's flora and fauna. Kiore are known to eat insects and lizards (Campbell et al. 1984, Newman and McFadden 1989) and both the stag beetle and skink lie within their known prey size (Moller 1977). Even if the effect of kiore is considered minimal, they are potential predators of beetles and lizards on Mokohinau (Atkinson 1978, Campbell et al. 1984, McCallum 1986, Whitaker 1978). Kiore are not known to be good swimmers, but they are present on most of the Mokohinau islands. They recently invaded Lizard Rock (Veitch 1978, McCallum 1980), but have since been eradicated. It is not known how kiore reached Lizard Rock, but their effect on that island's herpetofauna was dramatic. In 1973 Whitaker recorded sighting 65.4 lizards per hour of searching, while by 1977 McCallum failed to find any during 90 minutes (Whitaker 1973, McCallum 1986).

Prior to The Mokohinau operation, kiore were eradicated from Rurima and Korapuki Islands, using toxic grain in silos, and from Double Island using a combination of toxic grain in silos and manually broadcasting wax block rat bait (McFadden and Towns 1991, McFadden 1992). Significant populations of red-crowned parakeet (*Cyanoramphus novaeseelandiae novaeseelandiae*) were present on Korapuki and Double and are considered particularly vulnerable to the effects of direct poisoning, because of their known dietary preferences (Green 1988, Calder and Duess 1984). The eradication technique described in this report is a significant departure from those used on Rurima, Korapuki, and part of Double, and provided no protection for fauna. No application-rate data exists for control of rodents when the bait is broadcast. Because of this and the fact that Mokohinau are extremely modified with few terrestrial avifauna, there was justification for applying what, in hindsight, could be seen as an excessive amount of bait. This operation was viewed as the starting point from which, if successful, future eradications could be designed, with the intention of reducing application rates and developing methodology. The eradication attempt described in this report was proposed by DoC and Auckland Zoo for August 1990. The proposal included public education through a visitor display at the Zoo showing Mokohinau Is. and species at risk (stag beetle and skink) and captive management of the skink and possibly stag beetle.

2. STUDY AREA

The Mokohinau Islands are part of a broken chain of rhyolitic volcanoes within the Coromandel volcanic zone (Browne and Greig 1980). Situated some 110 km NE of Auckland, the group has the potential to provide significant refuges for endangered species. The group consists of Fanal (73 ha), Burgess (56 ha), Maori Bay (11 ha), Trig (16 ha), and 17 islets or stacks (Fig. 1). All but a few small outlying stacks were known to have kiore. Both the stag beetle and skink are known only from Stack H, from which kiore have never been recorded. Burgess and Trig have been extensively modified by stock associated with lighthouse keepers, and all islands have been extensively modified by fire. Muttonbirders from Great Barrier Island have frequently burnt the Knights Group. A lighthouse was erected at the summit of Burgess in 1883, and since then stock and fire have reduced its natural vegetation to remnants along cliffs. Most of Burgess is now covered in rank pasture grass, buffalo grass (*Stenotaphrum secundatum*), and club rush (*Scirpus nodosus*). Maori Bay and Trig possess a varied vegetation and provide some idea of what the species composition on Burgess may have been, although only Stack H appears truly unmodified. Both Maori Bay and Trig are dominated by extensive areas of dense flax (*Phormium tenax*), broken by emergent solitary or clusters of pohutukawa (*Metrosideros excelsa*) and, ngaio (*Myoporum laetum*). Bare ground beneath the pohutukawa has enabled some hardwoods to establish. The small associated stacks may have escaped fire, but although their vegetation appears little modified, their fauna has been affected by the presence of kiore.

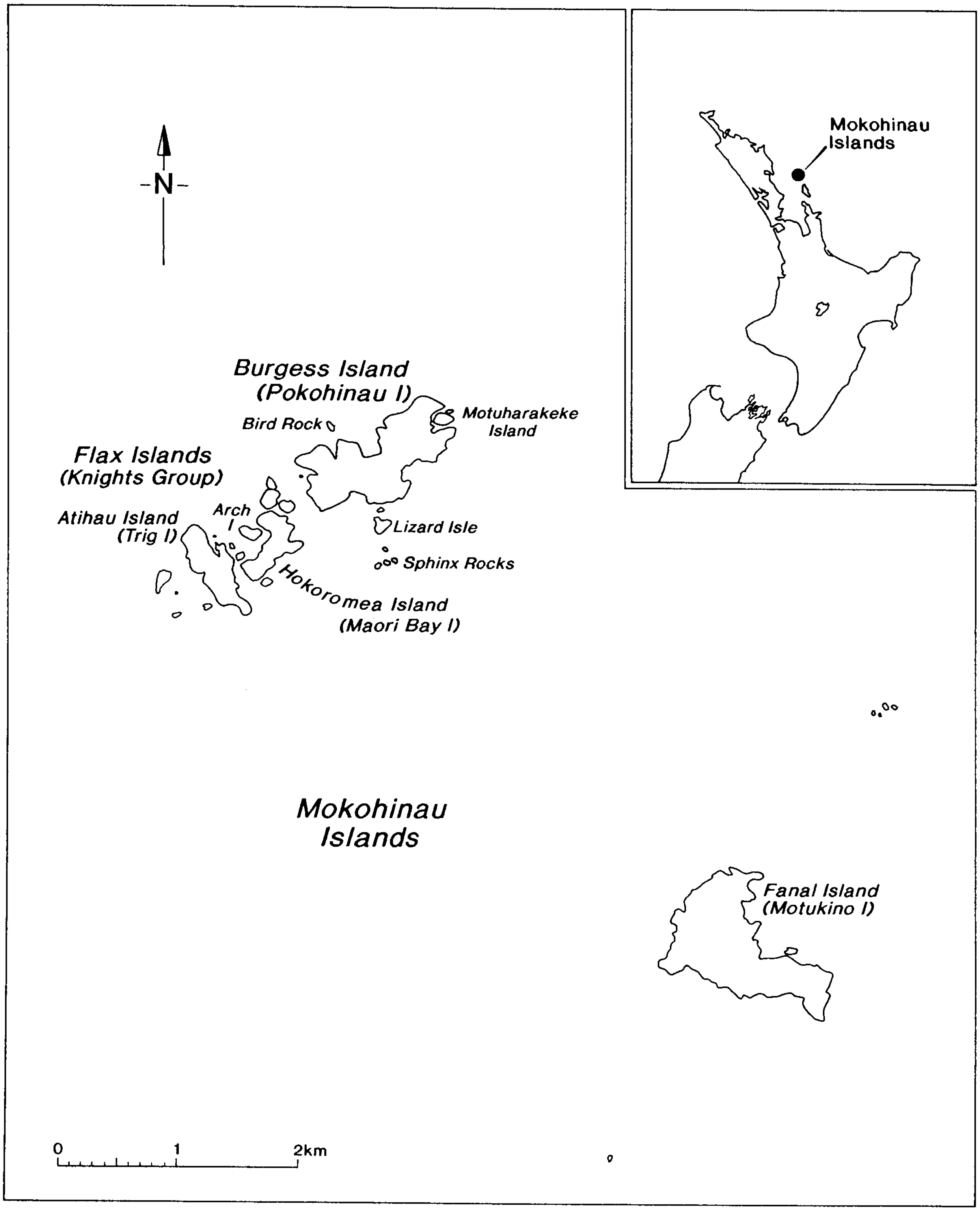

Figure 1 Map of Mokohinau Islands. Note that Fanal Island lies 5km to the southeast. Note also that the correct geographical name of the Knights Group is Flax Islands.

3. METHODS

3.1 Poison application

Burgess and the Knights Group, excluding Stack H and Lizard Rock, were treated with one application of Talon® 20 P in August 1990. A standard monsoon bucket and helicopter was used. Neither Dekka nor GPS navigational systems were thought to be appropriate, nor was wide swath considered essential, because application rate was high (c.30 kg/ha), and the islands small. In essence, it was saturation poisoning. Topographical features were used to record which portions of the island were treated, while the narrow swath delivered by the monsoon bucket was most appropriate for steep cliffs. Had a spreader been used a lot of bait would have ended up in the sea. The outlet plate of the bucket was adjusted so that bait flowed freely. Prior to treatment two sacks of bait were loaded into the bucket and a pass made over a flat on Burgess. After further adjustment of the plate and positioning 3 large boulders in the bottom of the bucket, which further reduced flow rate, the operation began. Working off a crude platform made from 4 pallets, four operators loaded sacks of bait into the monsoon bucket whilst the helicopter hovered. Two operators loaded previously opened sacks into the bucket whilst the other two stood by to accept the empty bags; this prevented the sacks, or plastic bags inside them, from being sucked into the helicopters intake. Bait dispersal was gauged by counting pellets lying within 53 grids 1 m x 1 m chosen at random along cliff edges, because the dense sward of grass, flax, or club rush elsewhere made pellet counts impractical.

As a precaution against kiore persisting in small areas which may have missed treatment by 20 P, one manual application of Talon® 50 WB was made. Operators spaced themselves 25-30 m apart as they traversed Burgess, casting bait at random. Where possible, baits were placed under vegetation or in sheltered places, rock crevices, under overhangs, etc. On Maori Bay, Trig, and the associated islets operators were assigned to specific parts of the island to apply bait, because these islands could not be easily covered by operators traversing abreast. Those areas unable to be reached from land were approached by boat and baits fired up into vegetation using a catapult.

3.2 Rat trapping

Following the air drop, snap trapping was conducted in an attempt to monitor die-off. Snap traps were set on all islands with easy access. Traps were marked with flagging tape, and at each site two traps were set, one baited with cheese, the other with peanut butter. Traps were checked daily on Burgess, but only when weather allowed on the Knights Group. Snap trapping was also carried out in October 1990, and June 1991. During all trapping sessions the traps were moved after 5 nights to allow better coverage of the islands. In October 1990, more Talon 50 WB was broadcast manually, and snap trapping for kiore complimented with searches for kiore sign (faecal pellets, feeding on fruit, seeds, scavenging on dead birds or flotsam). The trapping and searching was repeated in June 1991, when 16 permanent poison stations were set out (Fig. 2). These stations are 50 cm lengths of 110 mm diameter yellow novacoil, held down by rocks and containing wax block rat baits sealed in plastic bags to prevent insects and moisture ruining them.

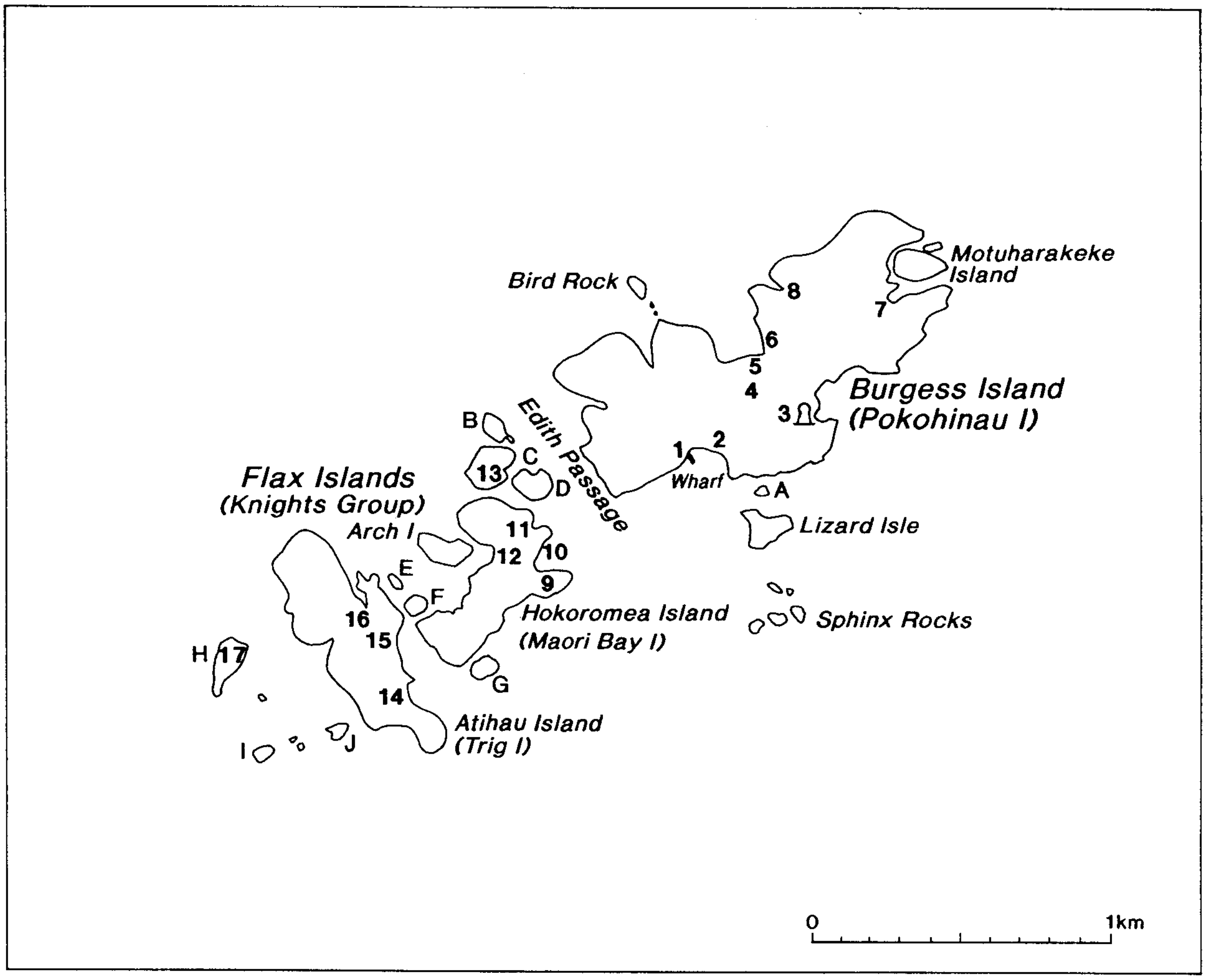

Figure 2 **Location of permanent bait stations on Burgess and the Knights Group.**

3.3 Non-target monitoring

Five-minute bird counts concentrating on parakeets were conducted along a transect running the length of Burgess Island (east to west) in August and October 1990. Experience has shown that five-minute bird counts (Dawson and Bull 1975) can be used to provide useful indices of abundance for red-crowned parakeet (Dawe 1979, Calder and Duess 1984, Greene 1988). Eight stations were marked out at approx. 200 m intervals. The number of parakeets seen or heard at these points within a radius of 200 m over a period of five minutes was recorded. All counts were made between one and three hours after sunrise, when parakeets are known to be more conspicuous (Calder and Duess 1984, Greene 1988). To gauge what effect the poison had on non-target species, careful records were kept of all birds found dead, or any evidence of secondary poisoning.

3.4 Monitoring seabirds

In the long term, it is expected that some changes may occur in densities of burrow nesting seabirds, and with species composition. The effect rodents have on small

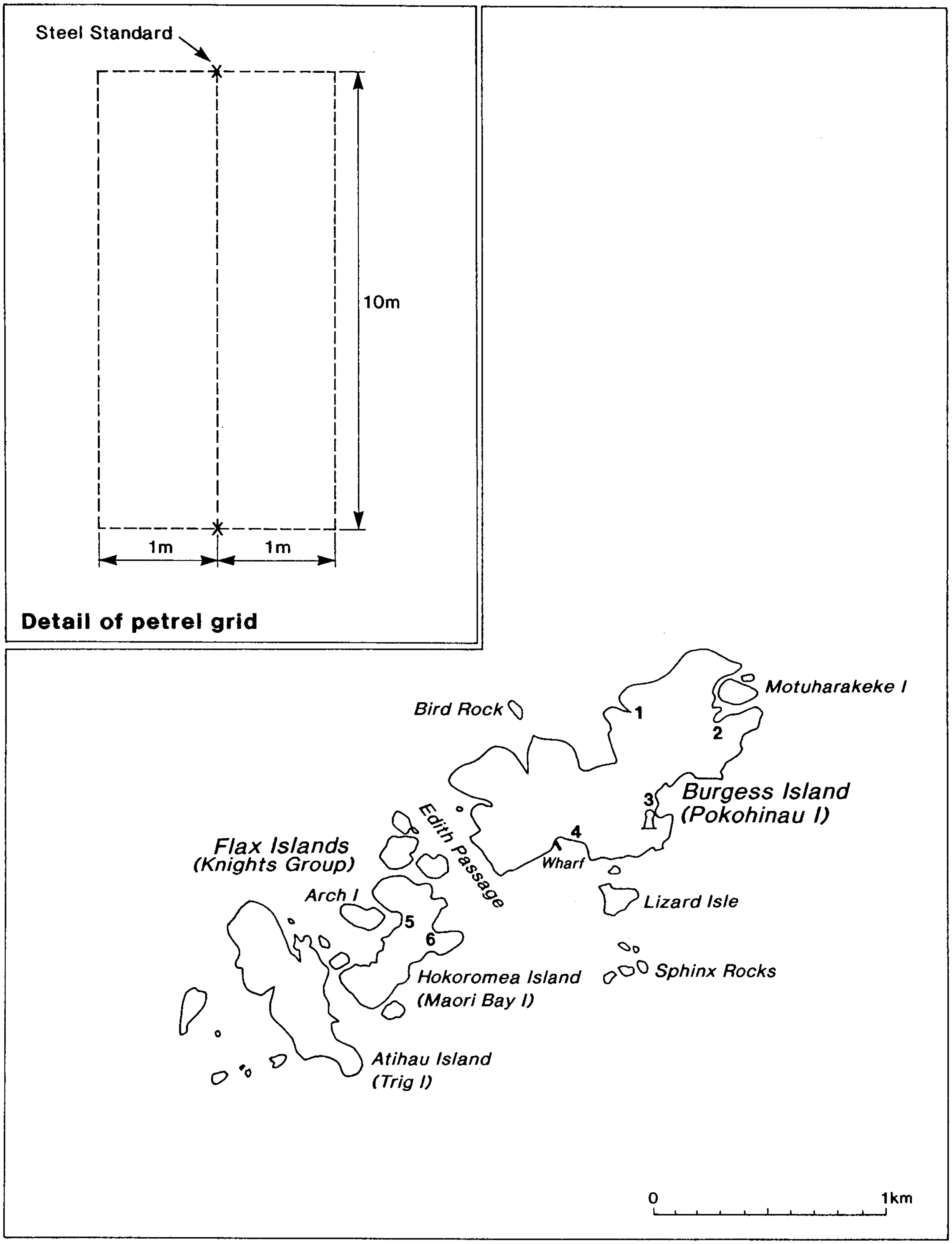

Figure 3 Location of petrel grids on Burgess and the Knights Group.

4 RESULTS

4.1 Poison application

A total of 3 tonne of 20 P was dropped, taking about 2 hours flying time. The bucket operated satisfactorily and® gave an acceptable bait spread. The narrow swath width (c.5 m) provided adequate coverage, given that the objective was saturation poisoning. Sufficient bait remained after all the islands had been treated to enable a few areas of Burgess to be retreated. Pellet counts in the 53 1 m x 1 m grids gave huge variations. The average from 43 grids on Burgess was 9.7 (s.d. 2.1) and from 10 on Maori Bay 5.7 (s.d. 2.7). For an even application of 3 tonne on the islands treated, this pellet count should have been 4.2, suggesting bait was concentrated along ridge tops and cliff edges. Talon 50 WB was broadcast manually at a rate of 2.0 kg/ha or 130 baits per hectare. In total, 400 kg of 50 WB was applied between August and October 1990.

4.2 Rat trapping

Snap trapping in August aimed at monitoring rat die off yielded very few kiore. Traps set where the lighthouse keepers' houses had once been sited yielded two kiore. Both were caught on the first night after the poison drop and both had stomachs full of 20 P Three dead kiore found later also had stomachs full of bait and blood in their abdominal cavity. Snap trapping in October 1990 and June 1991 failed to detect the presence of kiore. Details of trapping effort are provided in Table 1.

Table 1 Trapping effort on Mokohinau Islands

	Trap nights				
	Burgess	Maori Bay	Trig	Stack C & D	Kiore
August 1990	720	0	0	0	2
October 1990	1560	336	360	360	0
June 1991	2112	360	352	224	0

Note: 1 trap night = 1 trap set for 1 night.

The sole purpose of snap trapping was to detect the presence of kiore. For this reason, only trapping effort and actual number of rats is presented in this table. On Trig Island, in October 1990 for example, 30 traps were set for 12 nights, and the resulting 360 trap nights yielded no kiore. As this is not index trapping, no corrections for trap interference have been made.

4.3 Non-target monitoring

One female chaffinch was found dead in August. It had green staining about its beak and fragments of wax and grain inside its mouth. In October, another chaffinch, three harrier hawks, and one song thrush were found dead. All birds were at a similar state of decay. No dead red-crowned parakeets were found, despite one seen feeding on 50

WB near the bunkhouse. Five minute parakeet counts along the transect were completed 15 times in August, and 20 times in October. Frequently, no parakeets were observed at all during the five minute counts, which is reflected in the large degree of variability expressed by the standard deviation. These data indicate an increase in the conspicuousness of parakeet after the poison drop (see Table 2), and suggest that there has at least been no obvious drop in populations.

Table 2 Five minute parakeet counts

	August	October
Mean ± SD for individual counts	1.6 ± 1.56 (n=120)	1.91 ± 2.38 (n=160)
Mean ± SD for pooled counts	9.87 ± 4.66 (n=15)	15.3 ± 5.92 (n=20)

Means and standard deviations for all five-minute bird counts are presented. The large number of counts in which no parakeets were observed (48.3% during the poisoning operation, and 39.4% in October) is reflected in the large degree of variability expressed by the standard deviations. To reduce this variability, the number of parakeets seen at each count point has also been pooled for individual transects.

4.4 Monitoring seabirds

The transects set out in August to monitor changes in burrow nesting seabirds were checked in June 1991, and again in April 1993, but no difference in occupancy rate was observed. A count of nests and estimate of the number of red-billed gulls *(Larus novaehollandiae* scopulinus) was made in October 1990 for future reference (Table 3). There are some early data available on this colony (Fleming 1946) and comparison of future changes in colony size may provide some insight into what effect, if any, kiore may have had on red-billed gulls. Fleming recorded 2685 birds in October 1944 and his estimate of the Mokohinau population was between 5,000 and 10,000 birds. This colony was spread out in 8 sites along the north side of Burgess and at 2 sites on the south side. By comparison, in October 1990 birds were confined to 3 sites on the north side, and the estimate of the Mokohinau population was 1100 to 1300 birds.

Table 3 Red-billed gull nests in October 1990

Empty nests	Nest with eggs	Total nests	Nests with			
			1 egg	2 eggs	3 eggs	4 eggs
116	243	359	94	141	7	1

Some nests were on steep cliffs and not visible from above, so that no egg count could be made, and those nests are not included in Table 3. A conservative estimate of those nests not accessible is 25, which is equal to 50 birds. The overall estimate of up to 1300 birds suggests that there has been a dramatic decline over the past 46 years.

5. DISCUSSION

5.1 Bait application

Kiore eradication methodology has progressed during the past 10 years from permanent bait stations on a small island to quite ambitious campaigns on large islands. Bait composition and methods of presentation were first trialed on Lady Alice Island (McFadden 1984), and led to the eradication of kiore on Rurima Rocks and Korapuki Island (McFadden and Towns 1991), where the labour intensive method using permanent bait stations on a grid system were used. To test if kiore could be eradicated by simply broadcasting wax block rat bait, an eradication attempt was launched against kiore on Double Island (McFadden 1992). On Rurima (7.5 ha), problems were encountered with the toxin used (1080), but when anticoagulants were introduced (bromodialone), eradication was achieved. Then followed the eradication attempt on the much larger Korapuki (18 ha), again using permanent stations. Manual broadcasting was used on the large islet of Double (19 ha) and compared to permanent bait stations on the smaller islet opposite (8 ha). The relative ease with which that eradication was achieved gave us confidence to attempt the eradication described in this report.

Problems encountered in previous eradication attempts (e.g., Noisies, see Moors 1985) have made some managers wary. The successful, but accidental removal of Norway rats from Whale Island, where various baits were applied to attempt to remove rabbits (*Oryctolagus cuniculus cuniculus*), gave some encouragement. However, because several toxins, baits and methods of application were used, it is unclear which were responsible for eradication of the rats.

Our eradication campaign on islands of the Mokohinau Group had the potential to achieve two objectives:

1. Eradicate kiore from those islands treated and create enormous potential for island restoration and/or habitat for endangered species sensitive to rodents.

2. Test the technique of broadcasting bait on a large scale, thus if successful, encouraging managers to look at the possibility of eradicating rodents from very large islands (e.g., Kapiti).

In fact, kiore were eradicated from the Mokohinau Islands with relative ease. The application rate using a standard monsoon bucket was high, but acceptable for the purpose of this operation. This operation relied upon saturation poisoning, to see if it worked. There were few non-target species on Mokohinau and those were monitored. Just how much bait is required to eradicate kiore is unknown, and future attempts using this aerial application method will be at a significantly reduced rate. The ideal may be to go as low as 5 kg/ha of 20 P and no follow-up of 50 WB. In future campaigns it may be advisable to use a purpose-built bucket with a bait spreader. Such buckets can be calibrated to allow for better bait distribution and provide a greater swath width.

5.2 Non-target species

Despite the heavy application on Mokohinau, very few non-target kills were observed. The vegetation on Burgess made finding birds easy, as the dense sward of buffalo grass made a thick mat upon which dead birds were conspicuous. If there had been significant deaths of parakeets or introduced passerines we would have detected it. Low levels of non-target kills may be experienced on forested islands where a greater diversity of birds exist, and ground feeding insectivorous birds like saddleback (*Philesturnus caruneulus rufusater*) would be more likely to encounter baits. The most common ground feeding insectivorous bird on Burgess is the blackbird (*Turdus merula*) and after the poison operation we were unable to find any dead. Even red-crowned parakeet which were seen feeding on 50 WB were not found dead. In fact, after the poison drop parakeets were apparently more conspicuous.

On Burgess, in particular, a possible reason for the low number of non-target species killed is that the 20 P aerially broadcast fell through the sward of rank grass and was not visible to birds. Only those birds frequenting bare patches of ground would have encountered bait. When manually broadcasting 50 WB, baits were hand placed under vegetation, and would have also been hidden to most birds.

Burgess Island and the Knights Group should now be considered rodent free and consideration can now be given to their restoration, or how best to use them for endangered species.

Most previous rodent eradication attempts have been based on setting out bait stations on a grid matrix or track system. This is a particularly laborious and expensive exercise. Each bait station has to be visited daily and replenished until bait take ceases. Dominant rats may take baits away to eat them, thus depriving subordinate rats access to them. Several days will elapse before dominant animals die and those lower down the pecking order have access to baits. On Breaksea Island, Fiordland, it took at least 21 days before bait take ceased and post poisoning monitoring could begin (Taylor and Thomas, in press). With aerial applications the bait is delivered in a matter of hours; all target animals have access to the bait on the first night, and the post poisoning monitoring can begin within 7 days.

Without a doubt the advent of second generation anticoagulants like Talon have made rodent control and eradication easier. Aerial applications of poison has been used on the mainland to control vertebrate pests, but not previously for an eradication campaign. Given that this campaign was successful, conservation managers may now have an efficient, effective and comparatively inexpensive method of rodent eradication.

5.3 Cost comparisons

Eradication campaigns are easy to cost out, if successful. However, it is difficult to compare the total cost of different campaigns, as the cost of servicing can vary enormously. For example, getting to Breaksea Island is much more difficult and expensive than travelling to Mokohinau. When looking at costs, the important factor is not what method is used, but the cost per hectare of applying the bait. The net cost relates solely to the cost of applying bait, so that a comparison may be made, for example, between applying 20 P by helicopter from a bucket, and setting out bait stations containing 50 WB. On Mokohinau, 4 people were needed to load the monsoon bucket and to carry out the manual application of baits, taking in total 12 person days. By comparison, on Breaksea Island, restocking the stations with bait alone needed 176 person days. Gross cost is the all up cost of the project, and these, with net costs for our campaign, are detailed in Table 4.

Table 4 Cost of Mokohinau Campaign (1993NZ$)

Net (cost of applying 20 P and 50 WB		$		$/ha
Helicopter (air drop only)		2750		
Poison 20 P and 50 WB		11680		
Wages @ $15/hr		1440		
Field supplies		240		
Area = 100 ha	Total	16110	or	161.10/ha
Gross (Poison application and all servicing)				
Helicopter (includes ferrying)		5000		
Poison		11680		
Wages		20160		
Field supplies		2000		
Boat charters		4200		
Sundries		1000		
Area = 100ha	Total	44040	or	440.40/ha

5.4 Conclusions

Our successful campaign on Mokohinau has shown that aerial applications can be effective and may have very little environmental impact. The next step will be to fine tune the methodology, perhaps aiming to apply just 20 P by air at a much reduced application rate. The grids set up to monitor changes in seabird numbers are not likely to produce results for several years, because most petrels are long-lived, and take many years to reach sexual maturity. Hence any expansion in their numbers will not be readily obvious. However, attempts by storm petrels to breed on these islands will be of interest, as it is assumed that their attempts in the past have failed due to kiore predation.

Because Mokohinau is frequently visited by the public, poison stations should be maintained and checked at least every 6 months to ensure that the islands are not reinvaded by rodents, which could get ashore from boats anchored offshore, or tied up at the landing on Burgess. Consideration should be given to establishing the Mokohinau skink, and stag beetle onto the small islets now free of kiore and which have vegetative cover similar to that of Stack H. However, before translocation can occur, the exact status of these two threatened species must be determined. With kiore now absent from those islets least modified by fire, some survey work may be justified to determine if the skink and beetle have persisted in the presence of kiore, albeit in low numbers.

Such work would also provide an opportunity to collect more information about the very animals for which this eradication campaign was undertaken.

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