Effects of a non-toxic bait application on birds

Assessing the impacts of a proposed kiore eradication programme on Little Barrier Island

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A B S T R A C T

The impacts of a proposed aerial toxin application to eradicate kiore (*Rattus exulans*) were investigated for a number of bird species. A non-toxic aerial bait drop using pyranine-dyed baits was carried out over a 30 ha area on the lower slopes of Little Barrier Island (Hauturu), Hauraki Gulf, New Zealand, in September 2003. Application methods were similar to those proposed for the eradication. Rat trapping indices and low bait removal (3.6% of baits removed over six nights) during the period of the study suggested that the kiore population was extremely low at that time of year. Despite the negligible rate of bait removal and an additional slow rate of bait decomposition, only one bird of 105 captured showed any evidence of having eaten bait. This result, combined with evidence from previous studies, suggests that the medium- to long-term benefits to the bird population resident on Little Barrier Island (Hauturu) arising from kiore eradication, far outweigh any perceived risks.

Keywords: non-toxic bait trial, biotracer, pyranine dye, bird species, kiore, *Rattus exulans*, eradication, Little Barrier Island (Hauturu), Hauraki Gulf, New Zealand

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1. Introduction

Kiore (*Rattus exulans*) are the only introduced mammalian predator remaining on Little Barrier Island, in the Hauraki Gulf, New Zealand. Given the mounting evidence of their impact on plants, insects, reptiles, birds and forest ecosystem processes (Campbell & Atkinson 2002; Pierce 2002; Imber et al. 2003), an application for resource consent to eradicate kiore using aerial application of cereal baits containing brodifacoum was lodged with Auckland City Council and Auckland regional council in October 2002. However, Little Barrier Island is a major stronghold for several endangered bird species; including stitchbird (*Notiomystis cincta*), saddleback (*Philesturnus carunculatus*) and North Island kokako (*Callaeas cinerea*). Concerns about the effects of spreading brodifacoum-laced bait were expressed at the resource consent hearing. These concerns were specified in an appeal against the consent lodged by Friends of the Earth New Zealand.

Since 1989 similar aerial poisoning operations have been undertaken on numerous offshore islands (McFadden & Greene 1994; Pierce & Moorhouse 1994; Towns et al. 1994; Empson & Miskelly 1999; Towns and Broome 2003) and the impact of the toxin on non-target species (particularly birds) is reasonably well-understood. There have been no recorded negative effects of these operations on birds at the population level. However, there are recorded examples of individual birds ingesting baits (e.g. Towns et al. 1994). Given that the Little Barrier kiore eradication could not be conducted before the winter of 2004, there was sufficient time to assess the accuracy of risk assessments through trials conducted on the island.

Little Barrier Island was visited during September 2003 to assess the effectiveness and impacts of an aerial application of bait over a small part of the island using the same techniques as would be used during the proposed kiore eradication. Bait would be applied at the same rate as an eradication operation. However, this bait would be non-toxic and contain a biotracer so that birds could be caught and examined to see if they had been eating the bait. The major aims of the visit were to:

- Assess the likelihood of birds eating the cereal bait
- Measure bait removal rates (by kiore and/or birds)
- Measure longevity (period of bait availability) of bait after the drop, i.e. the length of time bait is accessible to kiore and non-target species in a palatable state
- Assess the population status of kiore on Little Barrier Island
- Assess bait palatability to kiore on Little Barrier Island

2. Study area and itinerary

Little Barrier Island (Hauturu) (36°12′ S 175°7′ E) lies at the entrance of the Hauraki Gulf, approximately 24 km east of Cape Rodney (Fig. 1). The island, rising to a height of 722 m and covering an area of 3055 ha, is the rugged remnant of an ancient volcano. Vegetation on the island comprises several relatively undisturbed and highly diverse forest types (Greene 1998).

A 30 ha area, adjacent to dwellings on the lower slopes of the island, was chosen as the study area (Fig.1). The perceived risk to non-target bird species was thought to be considerably higher here than elsewhere on the island because of a history of feeding birds, the presence of semi-tame birds, and higher tolerance to human disturbance. The study area covered ridges and valleys, a variety of slopes and aspects, and a number of distinct forest types and

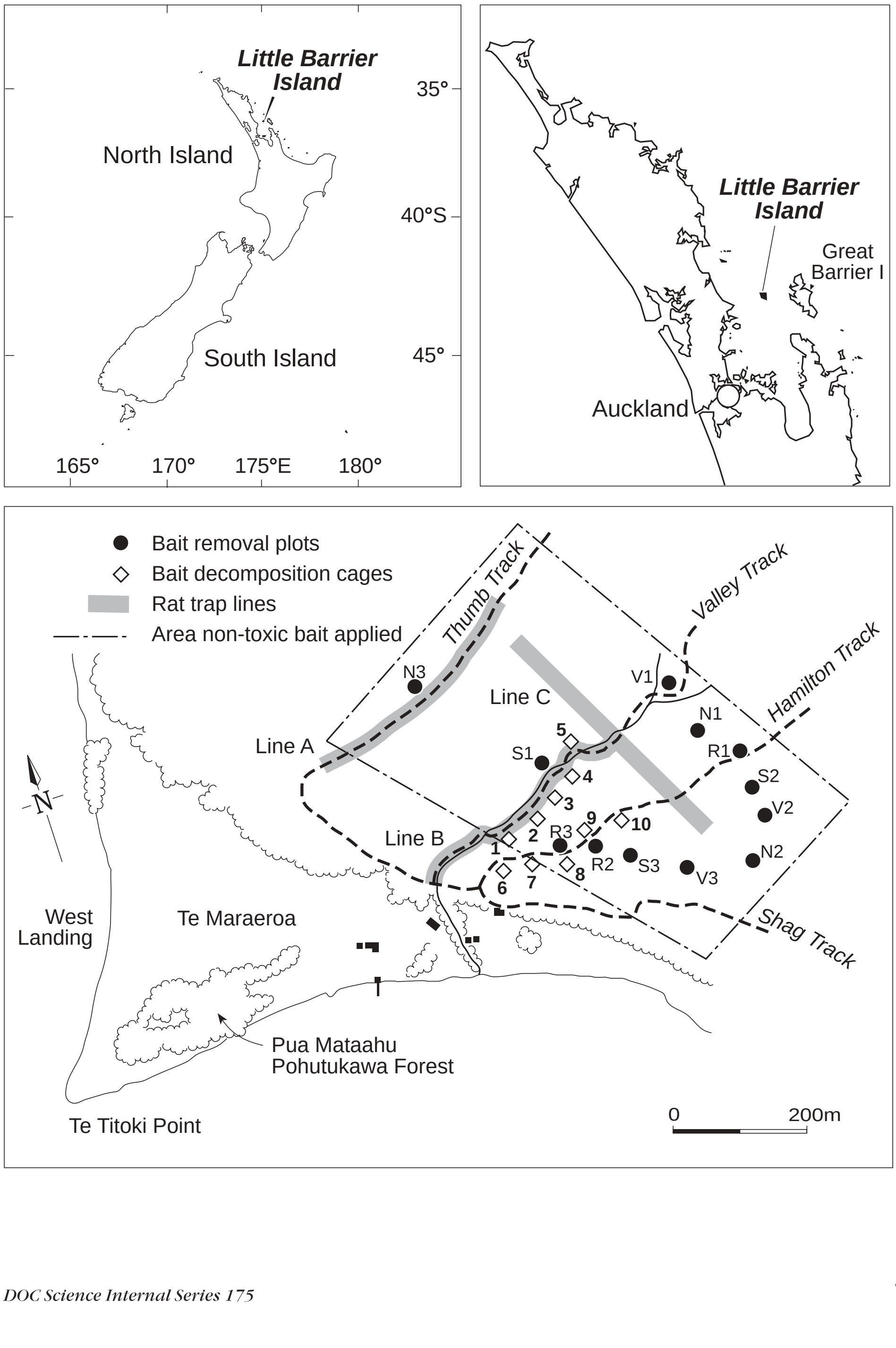

Figure 1. Location of Little Barrier Island (Hauturu), in the Hauraki Gulf. Bait sample plots, bait decomposition cages, and rat trap lines are shown within the study area (*lower, detail*).

structures. Both the area used, and the study design, were agreed to in consultation with representatives of Friends of the Earth, prior to the operation.

We flew out to Little Barrier Island by helicopter on 17 September 2003, and returned to Warkworth on 29 September. The bait drop was scheduled to be undertaken soon after our arrival, but poor weather conditions and problems with the spreader bucket meant this did not happen until the 23 September. Bait condition and bait removal rates were monitored and mist netting of birds carried out until our departure.

3. Methods

3.1 BAIT AND BAIT APPLICATION

Approximately 275 kg of freshly manufactured non-toxic PESTOFF 20R® baits were provided by Animal Control Products for this trial. The baits were cereal based, had a diameter of 12 mm, were dyed green and, for the purposes of this study, incorporated a non-toxic biotracer (Pyranine @ 0.4%) that fluoresced when exposed to an UV light source.

Initial plans to distribute baits by hand (as done on Macauley Island, Greene et al. in press) were rejected given the logistics of achieving accurate bait spread over a sufficient area and the requirement to mimic as closely as possible the conditions under which the actual eradication operation would be conducted. On 23 September a GPS-equipped helicopter using a specialist bait spreading bucket (Skyworks Ltd) was used to distribute bait over the study area. Prior to the operation the spreader bucket was calibrated to spread bait at 4 kg/ha. On Little Barrier Island the bait was dropped in parallel swaths flying across the slope with a 50% overlap resulting in a putative bait density on the ground of 8 kg/ha. The small amount of bait remaining following the calibration exercise was used to fill perceived gaps in coverage and to slightly increase the overall size of the treated area. Both the pilot and the supervising staff member (Simon Mowbray) were very pleased with the resulting aerial coverage.

3.2 BAIT MONITORING

Before the bait drop was undertaken we randomly chose 12 sites within the 30 ha study area where bait removal was to be monitored (see Fig. 1). To include the full range of habitats, three sites were chosen on each of the following aspects: south-facing slopes, north-facing slopes, ridge top and valley floor. Each plot site was marked with flagging tape and immediately following the air drop of bait we marked the nearest 25 baits around each site with numbered bamboo ‘kebab skewers’.

Plots were visited daily for the remainder of the trip and the number of baits present recorded. The distance between 10 of the marked baits on each plot was also measured.

As an indication of the likely effective life of the baits, we set out 10 wire cages each containing five baits (the cage prevented rats or birds from eating the baits). Five cages were placed along the damper valley floor and five along a dry ridge. At prescribed intervals each bait was assessed and scored for condition, where 1 was new bait and 6 was almost completely decomposed (Fig. 2, P. Craddock pers. comm.). This assessment was to be ongoing for up to four months following the bait drop.

Invertebrates seen on or under any baits were collected and preserved in alcohol for subsequent reference.

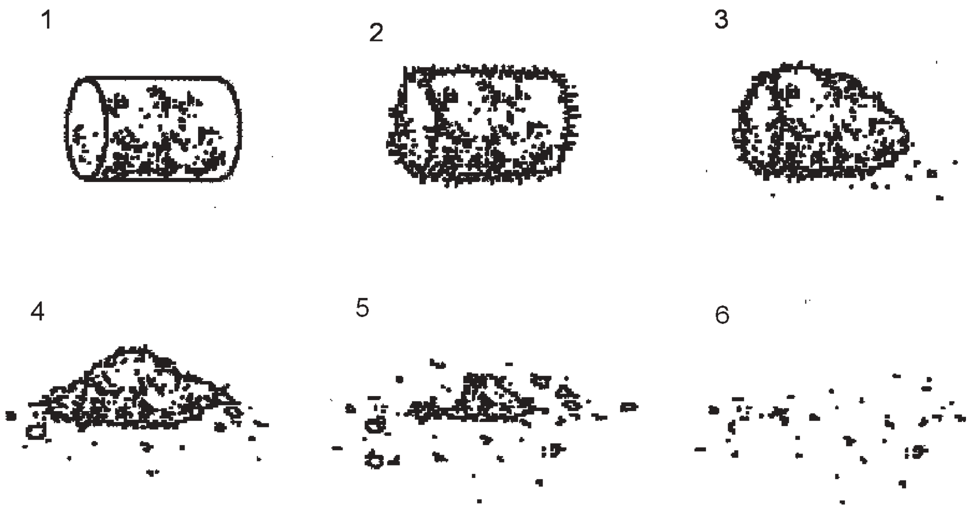

Figure 2. Scale used to measure bait decomposition (after P. Craddock pers. comm.).1 = fresh, 2 = soft (may have some mould), 3 = mushy pellet (> 50% may have some mould), 4 = pile of mush (> 50% with mould), 5 = disintegrating pile of mush, 6 = gone or identifiable by grain flakes.

3.3 BIRD MONITORING

During the aerial application of bait, eight observers were stationed in the study area to observe how birds reacted to the passing helicopter and to the bait falling to the ground.

The day after the bait application, mist nets were set within the study area to catch as many birds as possible. Initially we caught birds on Thumb Ridge and after two days moved the nets to Hamilton Ridge. Nets were set in a line along the track and these caught birds as they crossed the ridge. We patrolled the nets at regular intervals to remove any birds that were caught. Up to 13 nets 9–13 m in length were used concurrently. On 25 September, when it was too windy to use nets on the ridge tracks, we specifically targeted saddlebacks by moving around in the more sheltered valleys of the study area. One net was erected, and the territorial birds were attracted by playing recordings of saddleback calls. Using two speakers meant we could switch calls to either side of the mist net and thus lure birds into it.

All birds were checked for fluorescing pyranine about the bill and cloaca using a UV light source in darkened conditions (under a coat). The inside of catch bags and other faecal material (e.g. from kiwi (*Apteryx australis mantelli*) droppings found on the tracks) were also checked for traces of pyranine.

We attempted to catch birds whenever the weather was favourable (not windy) and five mist netting sessions of between 2½ and 9½ hours (approx. 26 hours in total) were carried out on 5 days following the bait drop.

3.4 STATUS OF KIORE

As an indication of kiore abundance, it was important to check whether they were at the expected 'mid-winter trough' in numbers (H. Speed pers. comm.) assumed for a July eradication attempt. We also wanted to assess the palatability of the non-toxic baits to kiore. Three standard snap trap lines were set out within the study area. Line A was set up along a ridge top, line B crossed north- and south-facing valley slopes, and line C was along a valley floor (see Fig. 1). A small number of the traps at the start of lines A and C were just outside the bait drop area. Each line consisted of 20 trap sites spaced 20 m apart. Each site had one Victor rat trap baited with peanut butter and placed inside a red corflute tunnel. Traps were checked daily for 5 nights.

4. Results

4.1 BAIT MONITORING

Average bait size was about 3 g and ranged from 2–4 g (R. Griffiths: Draft operation prescription of the eradication of kiore from Little Barrier Island. Drafted in 2002). The expected density of baits on the ground would, therefore, be about 0.27 baits per m^2. However, given the approximate area in which baits were tagged in most plots (an area roughly estimated at 50 m^2) actual bait density was closer to 0.5 baits per m^2. Distances between 110 baits within these plots (Table 1) also reflect this higher-than-expected bait density.

Of the 307 baits monitored at the 12 sites within the study area, only 11 baits (3.6%) were removed after six nights (Table 2). No pattern in bait removal was observed for any of the 'habitat types' sampled. No baits were removed from 6 (50%) of the plots. A maximum of 4 baits (16%) were removed from one plot over the monitoring period.

Bait condition and decomposition rate is highly dependent on rainfall. However, despite heavy rain on 26 September (6 days post drop; Table 3) and in subsequent weeks, bait integrity remained high—so much so that 96% of baits had only decomposed to condition 3 (see Fig. 2) 21 days following the bait drop.

Few invertebrates were seen on baits under cages or on baits within the 12 bait removal plots. Those that were seen included a few small slugs, ants, and some small beetles (≤ 2 mm). On a number of baits it was apparent that small amounts (< 5%) had been removed by these or other invertebrates.

4.2 BIRD MONITORING

Direct observations of bird/bait interactions at the time of the bait drop were inconclusive, given the dense vegetation and steep terrain. Although there were

TABLE 1. DISTANCES (IN cm) BETWEEN 10 MARKED BAITS ON THE BAIT SAMPLE PLOTS*.

PLOT	V1	V2	V3	N1	N2†	S1	S2	S3	R1	R2	R3
	76	68	40	110	62	70	118	82	135	59	50
	180	73	126	40	55	16	196	128	64	104	200
	130	33	36	175	73	210	13	82	80	123	210
	170	144	54	35	166	73	74	80	110	264	20
	210	42	53	120	100	7	88	121	23	250	135
	270	122	89	350	172	43	60	21	55	130	30
	130	63	73	190	83	159	50	124	245	79	58
	310	99	132	210	74	182	55	194	140	130	80
	34	23	54	60	28	69	109	123	190	82	85
	110	19	82	21	134	110	107	158	130	154	8
Mean	162	68.6	73.9	131.1	94.7	93.9	87	111.3	117.2	137.5	87.6
SD	84.8	42.2	33.7	102.6	48.0	69.6	50.0	47.8	66.4	69.2	71.8

* Plot locations are indicated on Fig. 1. Letters indicate orientation: S = south face, V = valley floor, N = north face, R = ridge-top.

† Plot N3 was not measured.

TABLE 2. CUMULATIVE NUMBER OF BAITS REMOVED FROM PLOTS OVER TIME.

DAYS AFTER DROP	PLOTS*											
	S1	S2	S3	V1	V2	V3	N1	N2	N3	R1	R2	R3
1	0	0	0	0	0	0	0	0	1	0	0	4
2	1	0	0	0	0	0	0	0	1	0	0	4
3	1	0	0	0	0	0	0	0	1	0	0	4
4	1	0	0	0	0	0	0	0	2	0	0	4
5	1	0	0	0	0	0	0	0	2	0	0	4
6	2	0	1	0	0	1	0	1	2	0	0	4
Overall	2	0	1	0	0	1	0	1	2	0	0	4

* Plot locations are indicated on Fig. 1. Letters indicate orientation: S = south face, V = valley floor, N = north face, R = ridge-top.

TABLE 3. WEATHER RECORDS OVER THE PERIOD OF THE TRIAL.

DATE (Sep. 2003)	RAIN-FALL (mm)	DRY BULB (°C)	WET BULB (°C)	MAXI-MUM (°C)	MINI-MUM (°C)	RELATIVE HUMIDITY (%)
17	0	13	12	–	10.5	92.3
18	0	16.5	13.5	17	12	81.8
19	0	15.5	15	18.5	7	96.8
20	0	–	–	–	–	–
21	32	17	14.5	19.5	11	85.3
22	0.9	14	12	20	11	85.7
23	3	14	12	17	11.5	85.7
24	3	15.5	15	11.5	–	96.8
25	0	16.5	15	18	11.5	90.9
26	0	17	15	19.5	–	88.2
27	0	18	16.5	20	8.5	91.7
28	0.7	17.5	17	19	11	97.1
29	16.5	12.5	10	–	10	80.0

no direct observations of bird interactions with baits, considerable evasive reaction to the low-flying helicopter was observed.

A total of 105 birds comprising 13 species (Table 4) were captured in mist nets following the bait drop. By far the majority of the birds captured were forest passerines. Only one red-crowned parakeet (*Cyanoramphus novaezelandiae*) was captured and no kaka (*Nestor meridionalis*) were caught.

All birds were examined for traces of dye, but only one saddleback of the 11 caught (< 1% of total birds) returned a positive result (dye on bill). None of the kiwi droppings found within the study area returned a positive result.

TABLE 4. BIRDS CAUGHT AND EXAMINED FOLLOWING THE AERIAL APPLICATION OF PYRANINE-DYED BAIT.

DATE (2003) LOCATION EFFORT	24 SEP. THUMB RIDGE 9.5 hrs	25 SEP. THUMB RIDGE 2.5 hrs	25 SEP. VALLEY/ SHAG 6 hrs	26 SEP. THUMB RIDGE 3 hrs	27 SEP. HAMILTON TRACK 4.5 hrs	TOTAL NO. OF BIRDS
Fantail	4			2	1	7
Stitchbird	4	3			2	9
Bellbird	9			6	7	22
Tui	11			1	7	19
Whitehead	7	1	3	2		13
Tomtit*	4			1		5
Blackbird*	2			1		3
Robin*	1	1		1		3
Saddleback*	3		7†		1	11
G. Warbler	2	1			4	7
Rifleman	3					3
Song Thrush*	1	1				2
R.C. kakariki*					1	1
Total	51	7	10	14	23	105

* Species predicted to be at high risk.

† A saddleback caught (25 Sep 2003) on lower Valley track had dye on its bill.

4.3 KIORE MONITORING

Kiore density was extremely low during the study. Two rats were caught over 288 corrected trap nights. Both kiore were males and captured just outside the area in which bait was dropped. Neither of these rats showed any sign of pyranine dye. A single rat dropping was found on the Thumb Ridge track within the bait drop area and tested positively for the pyranine dye.

5. Discussion

Differences between the expected and actual bait density on the ground (0.27 baits per m^2 and 0.5 baits per m^2 respectively) were probably a function of two factors. Firstly, the area estimates used for the calculation were rough guesses imposed by time constraints on the day of the drop. Secondly, and probably more significantly, the average size of baits on the ground was around 2–2.5 g. This is slightly less than the average bait size (3 g) calculated prior to the drop, and gives a predicted bait density of 0.32–4.0 baits per m^2—figures much closer to that estimated following the bait drop. It seems likely that there was either some bait fragmentation during the drop (spinner damage?) and/or as a result of impacts with trees. This would account for the higher density of bait observed.

Prior to the drop the baits provided were noted to be extremely hard and dry and of extremely variable length (5–40 mm). Although this seems to have been a result of a bait batch manufactured at short notice (S. Mowbray pers. comm.), consistency in bait size should be more rigorously controlled for the actual eradication operation.

Despite the inconsistencies in bait size and bait density, the removal rate of baits was extremely low, suggesting that most baits will remain after kiore have been killed. Although this in part reflects the seasonally low density of kiore, it also implies that bait removal by non-target species was almost non-existent. This is despite a potentially high level of exposure immediately following the drop (high bait density) and over subsequent weeks (slow decomposition rates).

Although the rate of bait decomposition (observed and projected) was extremely slow in comparison with studies conducted at Tawharanui (P. Craddock pers. comm.), significant differences in baits and climatic variables are likely for the actual eradication operation. Bait diameter will be reduced from 12 mm (this study) to 10 mm (as per the eradication AEE) and the winter rainfall regime is likely to be significantly wetter.

Bait decomposition rates obtained in this study are more likely to represent a worst case scenario. There is likely to be a much lower risk to birds on Little Barrier Island than that experienced on Kapiti Island, because the bait density will be lower, the baits smaller, and both the altitude and rainfall higher (Empson & Miskelly 1999; D. Towns pers. comm.). Bait decomposition is likely to be more rapid, particularly in some of the wetter/higher habitats, and the non-target effects greatly reduced. This study therefore highlights the need to assess the perceived risk of such operations on a case-by-case basis, to avoid potentially flawed comparisons with previous operations where the operational and environmental parameters are significantly different. We recommend the following parameters be considered in any assessment of risk.

- Island size
- Habitat variability (biotic and abiotic)
- Expected rainfall patterns
- Bait density

- Bait size and consistency (including dryness)
- At-risk species present—known mortality and recovery rates

A number of bird species on Little Barrier Island remain at risk of primary poisoning: brown teal (*Anas aucklandica*), kaka, red-crowned parakeets, saddleback, tomtit (*Petroica macrocephala*), North Island robin (*P. australis longipes*) and introduced species such as blackbirds (*Turdus merula*) in particular. Although few of the at-risk species (such as robins, tomtits, and parakeets) and no kaka (see Table 4) were captured and inspected, we are confident that any mortality associated with the poison drop will have little long-term effect. This view is supported by a number of studies on other islands (e.g. Mokohinau, Tiritiri-Matangi, Kapiti, Mokoia, and Whatapuke Islands). These studies showed little, if any, long-term impacts of rodent eradication upon these non-target species, even when toxic baits were applied at over four times the density intended for the Little Barrier operation (McFadden & Greene 1994; Pierce & Moorhouse 1994; Empson & Miskelly 1999; Armstrong & Ewen 2001; Davidson & Armstrong 2002).

The single incidence of a positive pyranine trace (on one of 11 saddleback captured) highlights the susceptibility of this species to this type of poison operation. Even so, this was a much lower rate than that encountered on Mokoia Island, where there was an estimated 45% mortality rate for adult saddlebacks (Davidson & Armstrong 2002). Despite this level of mortality, the saddleback population recovered to its former level in 1–2 years.

It is intended to capture the extremely small resident population of brown teal on Little Barrier, so the risk to this species should be negligible.

There is some evidence that mortality of birds during aerial bait spread is highest in areas where birds are habituated to the presence of humans (Empson & Miskelly 1999). We consider that the tame kaka (Ratbag) and kereru (*Hemiphaga novaeseelandiae*) (Pidge), that frequent the ranger's residence should either be captured and held for the duration of the operation, or that bait distribution around the inhabited buildings and mowed pasture be done by hand and after dark.

In summary, we view the operation to remove kiore from Little Barrier Island using aerial spread of PESTOFF 20R® as posing a small risk to some bird species. However, these risks are lower than were faced in other successful operations (e.g. Kapiti Island) because of differences in bait dimensions and in local climatic conditions. Total extirpation of any bird species is extremely unlikely. Evidence from previous rat eradication operations over similar habitats, and our bait trials during this visit, give us confidence in our assessment. In the unlikely event of significant mortality of some bird species as a direct result of the kiore eradication programme, we would expect to see a rapid population recovery of the species in the absence of rats—probably to higher levels than before the operation.

6. Recommendations

- A small team of observers should be present on Little Barrier Island immediately prior to and during any kiore eradication operation, to assess any impacts on bird populations.
- The remnant brown teal population appears to be extremely small and, if possible, birds should be captured prior to the operation and held until all baits have decomposed.
- Given the extremely high-value advocacy role played by the tame kaka and kereru, careful consideration should be given to protecting them from any poison bait operation.
- As a result of this study, no change to the risk assessment, as defined in the AEE, is deemed necessary.

7. Acknowledgements

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