Field trials of fresh and long-life stoat baits in Northland, New Zealand

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ABSTRACT

Seven bait trials, each comparing two bait types, were undertaken in forest remnants and pasture of Northland, New Zealand, to compare the attractiveness to stoats of various baits. Each trial consisted of 35–45 sites, with two trapping tunnels containing alternative baits placed at each site, each of which contained a single Mark 6 Fenn trap. The bait types trialed were fresh rabbit, salted rabbit, freeze-dried rabbit, chicken egg and pilchard. McNemer's test and the Bradley-Terry paired comparison model were used to compare statistical differences in capture frequencies between pairs of baits. Rabbit meat was more effective in attracting stoats than were eggs or pilchards. Fresh rabbit meat also appeared to be more attractive to stoats than preserved rabbit meat. The results suggest that fresh rabbit meat is the more effective of the bait types commonly used in Northland. However, long-life baits such as salted rabbit meat may provide a practical compromise between efficacy and economy in many situations.

Keywords: stoat, *Mustela erminea*, capture frequencies, bait trials, rabbit, long-life bait, New Zealand

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1. Introduction

Mustelids, particularly stoats (*Mustela erminea*), prey heavily on a range of nationally threatened indigenous biota. Since the 1990s there has been a steady increase in the number and extent of mustelid control operations nationally. In Northland there are currently about 20 predator control operations undertaken by the Department of Conservation (DOC), landowners, and community groups with objectives aimed at the recovery of populations of North Island brown kiwi (*Apteryx mantelli*), pateke (brown teal: *Anas chlorotis*), and various threatened species of shorebirds, seabirds, and forest birds. One of the central problems for pest control operators in Northland is that there has been little work to determine 'best practice' for predator control, including the effectiveness of different long-life baits or lures. Whilst a number of bait trials have taken place nationally, mostly using captive animals (e.g. Spurr et al. 1999; Henderson et al. 2002; Montague 2002; Spurr et al. 2002), few have provided specific useful guidance for existing Northland predator control programmes.

Miller (2003) undertook a preliminary trial of fresh rabbit (*Oryctolagus cuniculus*) meat and freeze-dried rabbit meat as stoat bait in eastern Northland. Key recommendations from that study were to carry out a series of statistically robust trials to determine the relative attractiveness of fresh rabbit meat in relation to a variety of potential 'long-life' baits, followed by a comparison between the best performing long-life baits. Seven paired trials were subsequently implemented by DOC near Whangarei, Northland, from 2002–06. This report summarises the findings of these seven trials.

2. Study areas and methods

2.1 STUDY AREAS

Seven paired trials, each comparing two bait types, were undertaken within 30 km of Whangarei. Three trials each were carried out in the Mimiwhangata and Whananaki areas where Miller (2003) had carried out the first Northland trial. These sites are located 25–30 km noth-northeast of Whangarei and comprise coastal lowlands dominated by contiguous areas of pastoral land, streams, wetlands, and dwellings, adjacent to rolling hill country, often with extensive remnants of secondary indigenous forest. During the study, both sites were the focus of recovery management for the acutely threatened pateke, which is preyed on by mustelids and other introduced predators.

A separate paired trial was undertaken in the Whangarei Kiwi Sanctuary, which includes several locations in the Motatau–Purua area, 20–25 km northwest of Whangarei, and at Bream Head, 25 km southeast of Whangarei. These sites comprise forest remnants (< 800 ha) bounded by pasture in the Motatau–Marlow–Purua area and at Bream Head. With the exception of Bream Head, all

of the Kiwi Sanctuary sites are inland locations. During the study, all of the Kiwi Sanctuary sites were subject to recovery management to protect and enhance the population of chronically threatened North Island brown kiwi, which is also preyed on by mustelids and other introduced predators.

2.2 METHODS

2.2.1 Trap sites and traps

Mimiwhangata, Whananaki, and the Whangarei Kiwi Sanctuary were each treated as separate trial sites. Single-set Fenn (Mark 6) trap sites were established in pairs at Mimiwhangata (n = 44 paired sets), Whananaki (n = 45), and at the Whangarei Kiwi Sanctuary (n = 35). The paired sets were located up to 1 m apart, with the tunnel entrances closest to each other. Trap sites were typically 100–500 m apart.

Tunnels were either single-entrance plastic Philproof tunnels (Whananaki), wooden tunnels (Mimiwhangata), or 'best practice' wooden tunnels (Kiwi Sanctuary), the latter containing a floor and baffles. All tunnels had chicken netting placed over the closed end to enable animals to see and smell through the tunnel. In the plastic and wooden tunnels, traps were hazed with twigs to direct animals across the trap plate.

2.2.2 Bait types

Five bait types were tested: fresh rabbit, salted rabbit, freeze-dried rabbit, fish, and chicken eggs. In tunnels without a floor, rabbit meat was placed on a 'pigtail' of wire at the closed-off end of the tunnel. Rabbit meat comprised a single c. 50 mm cube of fresh rabbit (thawed from frozen), salted rabbit (overnight salting of cubes), or freeze-dried rabbit (produced by Western Freeze-Dry, 119 Bethells Road, Waitakere, Auckland). Rabbits were gutted, but not skinned, except for salted rabbit which was also skinned prior to salting. Chicken eggs comprised a single brown egg (size 6 or 7) placed on the ground or floor of the tunnel. The fish bait was pilchards, comprising a single salted pilchard. Pilchards were obtained in vacuum packs from Penguin Wholesalers Ltd. The baits being trialed were randomly allocated within the paired stations. All old baits were collected and removed from the trap sites and dead animals were deposited at least 20 m from the capture site.

2.2.3 The trials

Fresh rabbit meat was used as one of the baits in all trials undertaken at Mimiwhangata because of 'maximum practicable effort' being directed at protection and enhancement of the critically important population of pateke at the site, and because fresh rabbit bait was considered to be very effective for stoat trapping in Northland (NM and S. Allan, DOC, pers. obs.). Details of the baits used in the trials are provided in Table 1. The first two trials focused on comparing fresh rabbit meat with pilchards, both of which are frequently used in Northland. In three subsequent trials (3, 4, and 7) we focused on comparing the national best practice bait (egg) against different rabbit meat baits. Finally,

TABLE 1. DETAILS OF TRIALS COMPARING FRESH RABBIT, SALTED RABBIT, FREEZE-DRIED RABBIT, PILCHARDS, AND CHICKEN EGGS AS BAITS FOR STOAT TRAPPING.

TRIAL AND LOCATION	TRIAL DURATION	BAITS TESTED
1 Mimiwhangata	30 Sep 2002 – 25 Sep 2003	Fresh rabbit v. pilchard
2 Whananaki	17 Dec 2002 – 25 Nov 2003	Fresh rabbit v. pilchard
3 Mimiwhangata	25 Sep 2003 – 28 Jun 2004 and 23 Sep 2004 – 9 Dec 2004	Fresh rabbit v. egg
4 Whananaki	25 Nov 2003 – 17 Dec 2004	Freeze-dried rabbit v. egg
5 Mimiwhangata	9 Dec 2004 – 30 Mar 2006	Fresh rabbit v. salted rabbit
6 Whananaki	17 Dec 2004 – 17 Mar 2006	Freeze-dried v. salted rabbit
7 Whangarei Kiwi Sanctuary	1 Dec 2003 – 31 May 2005	Salted rabbit v. egg

we compared fresh rabbit meat with one of the long-life rabbit baits (Trial 5) and two long-life rabbit baits (Trial 6).

2.2.4 Trap checking

At Mimiwhangata the protocol was to check traps twice each week and captured animals were removed from the traps, which were then re-set. Fresh rabbit meat was replaced during these twice-weekly checks. If long-life baits were being trialed they were not replaced until scheduled for bait replacement, every two weeks.

At Whananaki, checks were made weekly, animals removed and any sprung traps were reset, but baits were replaced fortnightly. There was a significant deviation from this protocol. In Trial 6 at Whananaki, in the period from 17 December 2004 to 31 May 2005, replacement of salted rabbit meat (but not freeze-dried rabbit) was changed from fortnightly to weekly, which lessened the value of that data for comparing the efficacy of the two long-life rabbit baits.

At the Whangarei Kiwi Sanctuary (Trial 7) all traps were checked fortnightly throughout the study, animals removed and baits were replaced at the same time.

2.2.5 Data

During each trap check, records were kept of mustelid species captured and (in the Whananaki trials) the age, sex, and state of decay of each specimen. The latter was intended to help with determining the approximate timing of an animal's capture in relation to the trap-checking regime. All by-catch information was also recorded, including rats (*Rattus* sp.), hedgehogs (*Erinaceus europaeus*), and feral house cats (*Felis catus*). Cats were aged and sexed.

2.2.6 Statistical analyses

Data were included for analysis provided they were not biased by other significant trapping events that could have influenced subsequent captures, including the following:

- When both traps at a location were sprung, no information on bait preference could be inferred, and these data were therefore excluded from the analysis.

- When a stoat had been caught in the previous week, any subsequent capture in the same paired trap site was excluded from the analysis because of the potential for stoat scent to attract other stoats (no other captures were treated this way but future analyses could consider doing so to test for influence of different by-catch species).

McNemar's test (McNemar 1947) was used to test the significance of catch rates between each pair of baits. McNemar's test can be used to test for preference between two treatments in matched samples. The exact (binomial) method, which is equivalent to the nonparametric sign-test, was used to obtain the *P*-values. Separate tests were performed for each animal type (stoats, all mustelids, cats, rats) in each trial. Each test provided a *P*-value representing the probability of getting the observed or a more extreme result under a null hypothesis of no preference between baits. *P*-values less than 0.05 are generally considered to indicate a statistically significant difference in preference.

An analysis comparing all baits across all trials was then performed. This was possible because, although not all pairs of baits were tested directly, there were sufficient indirect combinations to enable all comparisons to be made. For example, fresh rabbit was not compared directly with freeze-dried rabbit, but could be compared indirectly by combining Trial 5 which compared fresh rabbit and salted rabbit, and Trial 6 which compared salted rabbit with freeze-dried rabbit. This combined analysis was performed by fitting the Bradley-Terry model (Agresti 2002) using the SAS procedure GENMOD (SAS Institute 2000).

The Bradley-Terry model assumes that if the probability of bait *i* being preferred to bait *j* is p_{ij}, then $\log(p_{ij}/(1 - p_{ij})) = x_i - x_j$, where the x_i, x_j, etc., are model parameters, with one parameter estimated for each bait type. This model can be used to provide estimates of the odds ratios for each bait against a reference bait. In this case, fresh rabbit was chosen as the reference bait. The odds ratio for a bait is the probability of selecting that bait divided by the probability of selecting the reference fresh rabbit bait. For example, if a bait has an odds ratio of 1, it is equally likely to be chosen as fresh rabbit. However, if it has an odds ratio of 0.5, it is only half as likely to be chosen as fresh rabbit. In the Bradley-Terry model, the odds ratio for bait *j* versus bait *i* is estimated by $\exp(x_i - x_j)$. PROC GENMOD provided estimates and 95% confidence intervals of the odds ratios and was also used to test the statistical significance of pairwise comparisons between baits without adjustment for multiple comparisons ($P = 0.05$). The SAS code for fitting the model is given in Appendix 1.

3. Results

3.1 TOTAL CAPTURES

Approximately 300 mustelids were caught in the trials (Appendix 2), 253 of which were assessed as being suitable for analysis, comprising 226 stoats, 23 weasels (*Mustela nivalis*), and 4 ferrets (*Mustela furo*). Other predator species caught as by-catch included over 40 feral house cats, several hundred rats (*Rattus norvegicus* and *R. rattus*), and 135 hedgehogs. The stoat results for each trial are presented below.

3.2 STOAT CAPTURES

The results of the McNemar's tests are given in Table 2. They show, for example, that fresh rabbit was significantly preferred over pilchard by stoats in Trial 2 ($P = 0.039$), but this preference was not quite statistically significant at the 5% level in Trial 1 ($P = 0.070$).

The odds ratios for stoat catches of each bait compared with fresh rabbit bait are presented in Fig. 1. The 95% confidence intervals show that the preference by

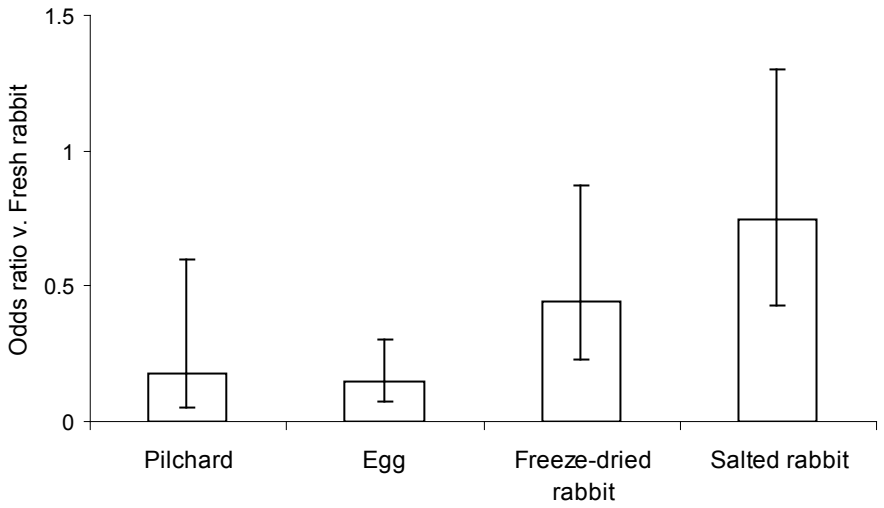

Figure 1. Stoat catch odds ratio estimates and 95% confidence intervals for each bait compared with fresh rabbit bait. Note that if the interval does not include one, the bait preference differs significantly from the preference for fresh rabbit.

TABLE 2. *P*-VALUES CALCULATED USING MCNEMAR'S TEST COMPARING BAITS FOR STOATS IN EACH TRIAL.

TRIAL AND LOCATION	TEST	*P*-VALUES FOR STOATS	NO. STOATS CAUGHT
1 Mimiwhangata	Fresh rabbit v. Pilchard	0.070	7 v. 1
2 Whananaki	Fresh rabbit v. Pilchard	0.039	10 v. 2
3 Mimiwhangata	Fresh rabbit v. Egg	<0.0001	31 v. 6
4 Whananaki	Freeze-dried rabbit v. Egg	0.003	24 v. 7
5 Mimiwhangata	Fresh rabbit v. Salted rabbit	0.211	25 v. 16
6 Whananaki	Freeze-dried v. Salted rabbit	0.050	25 v. 42
7 Whangarei Kiwi Sanctuary	Salted rabbit v. Egg	<0.001	19 v. 2

stoats for salted rabbit did not differ significantly from their preference for fresh rabbit, but that their preference for freeze-dried rabbit, egg and pilchard was significantly lower. The odds ratios for all animal types and pairwise comparisons between baits are shown in Table 3.

TABLE 3. ODDS RATIOS OF EACH BAIT COMPARED WITH FRESH RABBIT FOR STOATS AND TOTAL MUSTELIDS. ODDS RATIOS WITHIN A COLUMN FOLLOWED BY THE SAME LETTER DO NOT DIFFER AT THE 5% LEVEL OF SIGNIFICANCE.

BAIT	STOATS	ALL MUSTELIDS
Fresh rabbit	1.00 a	1.00 a
Salted rabbit	0.75 a	0.69 a
Freeze-dried rabbit	0.44 b	0.43 b
Pilchard	0.18 bc	0.31 bc
Egg	0.15 c	0.14 c

Interpretation of Table 3 requires some care, and to assist with this, a detailed explanation is given for stoats as follows:

- When both baits were presented together, fresh rabbit was chosen in preference to salted rabbits in a ratio of five to four (since the odds ratio approximates 0.8). However, this slight preference is not statistically significant since the letter 'a' follows the odds ratios for both baits.
- Fresh rabbit was twice as likely to be chosen as freeze-dried rabbit, and this difference in preference is statistically significant since the two odds ratios are not followed by a common letter.
- Salted rabbit was preferred to freeze-dried rabbit and this difference is statistically significant as the two odds ratios are not followed by a common letter.
- When pilchard was tested against fresh rabbit, it was chosen only one-fifth as often as fresh rabbit, and this difference is statistically significant since the two odds ratios are not followed by a common letter.
- Pilchard was also preferred significantly less than salted rabbit.
- The preference for freeze-dried rabbit over pilchard was not statistically significant, since the letter 'b' follows both.
- Eggs were preferred significantly less than all other baits except pilchard.

3.3 TIMING OF CAPTURE IN LONG-LIFE BAIT TRIALS

Trial 6 compared two types of long-life rabbit meat, namely salted and freeze-dried meat. Both McNemar's test (Table 2) and the Bradley-Terry analysis (Table 3) indicate that salted rabbit was significantly preferred to freeze-dried rabbit. Very few animals captured were classed as being 'fresh' when the traps were cleared (8% of captures using freeze-dried rabbit, n = 12; and 17% of captures using salted rabbit bait that were aged, n = 18). This indicated that most animals had been caught early in the baiting regime, i.e. when the baits were relatively fresh.

3.4 OTHER PREDATOR SPECIES CAPTURED

The statistical values for key animal species captured in each trial are provided in Appendix 3. As well as achieving higher captures for mustelids, the use of fresh rabbit also indicated more cat captures than when pilchards and eggs were used (Trials 1 and 3; Appendix 2). Significantly more rats were captured in trials using rabbit baits than either pilchard or egg.

4. Discussion

This study was carried out using paired-trap trials. The paired-trap design is extremely efficient for ranking baits. By presenting two alternative baits at each location, this design effectively eliminates site variation. Furthermore, the design and analysis is robust to variations in treatment protocol. For example, the different bait change times used in some of the trials in this study should not significantly affect the analysis. This is because such changes in protocols will apply equally to both baits at each location, and the analysis is purely concerned with establishing preferences between baits rather than absolute measures of effectiveness. The major disadvantage of the paired design is that it does not provide an absolute measure of trapping effectiveness. For example, if Bait A is chosen twice as often as Bait B in a paired design, this does not imply that in general use Bait A will trap twice as many animals as Bait B. To obtain absolute measures of bait effectiveness requires a design using single traps at each location with random allocation of baits. However, such designs are far less efficient at establishing bait preference rankings than paired designs.

The results of these trials indicate clearly that, in Northland forests and habitat mosaics, rabbit-meat baits are preferred by mustelids over eggs or pilchards. The consistently poor results for eggs in the Northland trials is particularly poignant given that eggs are used as a standard bait for mustelids across much of New Zealand (DOC, Animal Pests Best Practise Version 1.0; Yellow-eyed Penguin Trust 2002). The low preference for eggs when compared with the two long-life rabbit baits trialed here provides compelling evidence for Northland managers to primarily utilise rabbit bait in their trapping regimes.

Previous trial work in Northland (Miller 2003) indicated that fresh rabbit bait was better than long-life (freeze-dried) rabbit meat. The current trials also indicate that fresh rabbit is a more effective bait than freeze-dried rabbit meat. However, the difference in preference between fresh rabbit and salted rabbit was less clear and statistically not significant with only a slight preference for fresh meat over salted meat, i.e. fresh rabbit meat accounted for 60% of stoat captures when tested against salted rabbit meat. The predominantly rotten carcasses of target animals found in the separate long-life bait trial (refer to section 3.3) certainly adds weight to the argument that fresh rabbit meat is preferred to long-life rabbit meat. However, as it stands, the relatively similar performance of fresh and salted rabbit meat, may provide some encouragement for managers who wish to use salted or freeze-dried rabbit on a less frequent basis, e.g. using a fortnightly re-baiting regime.

If salted or freeze-dried rabbit is nearly as effective as fresh rabbit, as it appears to be, it can be argued that a cost-effective predator control regime would be to use salted rabbit bait with a fortnightly checking and replacement regime. The significant labour savings gained by less frequent checking and re-baiting could then be invested in expansion of the extent of the target area and/or moving to additional sites. Both strategies are attractive, given the wide-ranging behaviour of mustelids and some avifauna species. Because Northland managers (including many in community groups) currently find salted rabbit meat to be cheaper and more convenient to use than freeze-dried rabbit, evaluation of the relative attractiveness of salted rabbit meat compared with fresh rabbit meat merits continuation or replication. It was unfortunate that the frequency of bait changes for salted rabbit was increased to weekly during Trial 6, and, ideally, this trial should also be repeated.

The failure of pilchards and eggs to attract significant numbers of stoats in traps during these trials does not mean that they should not be used as baits in Northland. Mustelids can have individual patterns of hunting and this, together with the occasional presence of bait-shy animals, means that the use of alternative baits (to rabbit) could be effective in catching some of these animals. For instance, during the trial at Mimiwhangata in autumn 2005, several pateke were killed by a stoat or stoats, and a change to fresh rabbit meat resulted in the capture of a large male stoat in the killing zone, after which there were no more pateke deaths (NM, pers. obs.). Some other more novel baits, e.g. duck, could also be effective against stoats and warrant further investigation. If any of these baits were effective, they would have significant value as contingency baits. It is not clear if the use of white eggs with the shell pierced might have proven to be more attractive to stoats than intact brown eggs as trials undertaken elsewhere have apparently been inconclusive (E. Murphy, DOC, pers. comm.).

It is possible that rabbit baits could also be more effective than eggs in other parts of New Zealand where eggs are currently used as the main bait type, and some regional trialling is merited. For example, in North Canterbury, Montague (2002) found that rabbit meat was superior to rodents used as bait in attracting stoats to tracking tunnels. The relative attractiveness of rabbit baits in large forest tracts is also worth exploring further.

Finally, it is worth supplementing this experimental work during standard trapping operations by alternating bait types randomly between successive trap sites. This would remove the possibility of inter-bait interference in luring animals to the capture site in the first place. However, the alternative approach introduces potential site-specific biases, although these could be overcome in large, replicated trapping areas and by randomizing location of different bait types.

5. Conclusions

Rabbit meat was greatly preferred to pilchards or eggs by stoats and other mustelids when used to bait Fenn trap sets in Northland. It also appears that fresh rabbit meat was preferred over preserved rabbit (salted or freeze-dried), although both forms of treated rabbit meat attracted many stoats to traps. The performance of longer-life meat baits clearly merits further study.

Further trials and relative priorities for testing baits include the following:

- Continue with or replicate the fresh rabbit versus salted rabbit trial at Mimiwhangata, to determine whether there is a significant difference in the relative attractiveness of these two baits to mustelids (Priority One).
- Undertake trials of other meat baits that also, at least anecdotally, show some promise, e.g. salted possum versus salted rabbit, and salted duck or chicken versus salted rabbit (Priority One).
- Determine the duration of attractiveness of salted rabbit baits by undertaking paired trials using different timetables for checking and replacement of baits (Priority One). This could be extended to test outcomes for intensively monitored threatened species, e.g. kiwi and pateke, with thresholds set at appropriate levels (Priority Two).
- Repeat the comparison of salted rabbit versus freeze-dried rabbit because of the change to baiting frequency in Trial 6 at Mimiwhangata (Priority Two).
- Carry out supporting work in which different bait types are alternated between successive trap sites in standard stoat control regimes (Priority Two).
- Examine the influence of previous non-target captures (e.g. rats) as potential attractants (Priority One).
- Finally, consideration should be given to undertaking field trials in other parts of New Zealand where rabbit has not been used as a standard bait, e.g. rabbit versus egg or rabbit versus rodents (Priority One to Two).

6. Acknowledgements

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7. References

Agresti, A. 2002: Categorical data analysis. 2nd edition. Wiley, New York. 734 p.

Henderson, R.; Ross, J.; Frampton, C. 2002: Development of a long-life bait for control of stoats. *DOC Science Internal Series 51*. Department of Conservation, Wellington. 15 p.

McNemar, I. 1947: Note on the sampling error of the difference between correlated proportions or percentages. *Psychometrika 12*: 153–157.

Montague, T.L. 2002: Rabbit meat and rodent-scented baits as attractants for stoats (*Mustela erminea*). *DOC Science Internal Series 45*. Department of Conservation, Wellington. 14 p.

Miller, N. 2003: Paired trial of fresh and long-life stoat baits in a warm, coastal environment. *DOC Science Internal Series 100*. Department of Conservation, Wellington. 11 p.

SAS Institute Inc. 2000: SAS/STAT user's guide. Version 8, Volumes 1, 2, and 3. SAS Institute Inc., Cary, NC.

Spurr, E.B. 1999: Developing a long-life toxic bait and lures for mustelids. Pp. 1–23 in: Progress in mammal pest control on New Zealand conservation lands. *Science for Conservation 127*. 76 p.

Spurr, E.; O'Connor, C.E.; Airey, A.T.; Kerr, J.H. 2002: FeraCol for the control of stoats (*Mustela erminea*). *DOC Science Internal Series 61*. Department of Conservation, Wellington. 15 p.

Yellow-eyed Penguin Trust 2002: Field guide to mustelid trapping. Yellow-eyed Penguin Trust, Dunedin.

Appendix 1

SAS CODE FOR FITTING BRADLEY-TERRY MODEL TO THE STOAT CATCH DATA

```
title 'Bradley-Terry model, stoats';


data catch;
   input Ntot Ncatch R P E FDR SR;
   cards;
8  7     1     -1    0     0     0
12 10    1     -1    0     0     0
37 31    1     0     -1    0     0
31 24    0     0     -1    1     0
41 25    1     0     0     0     -1
68 25    0     0     0     1     -1
21 19    0     0     -1    0     1
;


proc genmod data=catch;
   model Ncatch/Ntot=P E FDR SR R/dist=bin link=logit
noint;
   output out=temp pred=pred;
   contrast 'R vs P' R 1 P -1;
   contrast 'R vs E' R 1 E -1;
   contrast 'R vs FDR' R 1 FDR -1;
   contrast 'R vs SR' R 1 SR -1;
   contrast 'P vs E' P 1 E -1;
   contrast 'P vs FDR' P 1 FDR -1;
   contrast 'P vs SR' P 1 SR -1;
   contrast 'E vs FDR' E 1 FDR -1;
   contrast 'E vs SR' E 1 SR -1;
   contrast 'FDR vs SR' FDR 1 SR -1;
run;
```

Appendix 2

SUMMARY OF NORTHLAND TRAPPING DATA 2002–05

TRIAL AND LOCALITY	DATE	BAITS	STOATS	TOTAL	CATS MUSTELIDS	RATS
1 Mimiwhangata	Oct 02–Sep 03	Fresh rabbit	7	9	9	137
1 Mimiwhangata	Oct 02–Sep 03	Pilchard	1	4	2	71
2 Whananaki	Dec 02–Nov 03	Fresh rabbit	10	17	3	148
2 Whananaki	Dec 02–Nov 03	Pilchard	2	4	0	146
3 Mimiwhangata	Oct 03–Jun 04	Fresh rabbit	31	33	7	167
3 Mimiwhangata	Oct 03–Jun 04	Egg	6	6	1	64
4 Whananaki	Dec 03–Dec 04	Freeze-dried rabbit	24	27	0	120
4 Whananaki	Dec 03–Dec 04	Egg	7	8	0	41
5 Mimiwhangata	Dec 04–Mar 06	Fresh rabbit	25	26	3	42
5 Mimiwhangata	Dec 04–Mar 06	Salted rabbit	16	16	3	42
6 Whananaki	Dec 04–Mar 06	Freeze-dried rabbit	25	26	2	21
6 Whananaki	Dec 04–Mar 06	Salted rabbit	42	42	0	21
7 Whangarei Kiwi Sanctuary	Dec 03–May 05	Salted rabbit	19	22	10	10
7 Whangarei Kiwi Sanctuary	Dec 03–May 05	Egg	2	4	0	9

Appendix 3

P-VALUES CALCULATED USING MCNEMAR'S TEST COMPARING BAITS FOR EACH ANIMAL TYPE IN EACH TRIAL

TRIAL AND LOCATION	TEST	STOATS	ALL MUSTELIDS	CATS	RATS
1 Mimiwhangata	Fresh rabbit v. Pilchard	0.070	0.267	0.065	<0.0001
2 Whananaki	Fresh rabbit v. Pilchard	0.039	0.007	0.250	0.953
3 Mimiwhangata	Fresh rabbit v. Egg	<0.0001	<0.0001	0.070	<0.0001
4 Whananaki	Freeze-dried rabbit v. Egg	0.003	0.002	1.000	<0.0001
5 Mimiwhangata	Fresh rabbit v. Salted rabbit	0.211	0.164	1.000	1.000
6 Whananaki	Freeze-dried v. Salted rabbit	0.050	0.068	0.500	1.000
7 Whangarei Kiwi Sanctuary	Salted rabbit v. Egg	<0.001	0.001	0.002	1.000