Developing a long-life toxic bait and lures for mustelids

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ABSTRACT

Predation by mustelids, especially stoats, is an important factor in the continued decline of several New Zealand bird species. The Department of Conservation currently uses Fenn traps in tunnels baited with domestic hen eggs as the main method of stoat control. An attractive and long-lasting bait incorporating a toxicant is urgently needed as an alternative to trapping. Captive stoats readily ate freshly dead animals (such as mice and day-old chickens), fresh raw meat, and raw hen eggs. Of these, only raw hen eggs are relatively long-lasting (1–2 months). Most of the potential long-life baits offered to captive stoats were not eaten at all (e.g. rat and possum baits) or were only nibbled at by some stoats (e.g. Du Pont cat baits, Salmon Services fishmeal pellets, and some commercial cat and dog biscuits). The only long-life bait that was reasonably palatable to stoats was a developmental cat bait called PussOff®. The smell of dead mice, dead day-old chickens, raw meat, and raw hen eggs were highly attractive to stoats, but the artificial odours and flavours tested were not. Sodium monofluoroacetate (compound 1080), diphacinone, and cholecalciferol were all shown to be suitable toxicants for adding to baits for stoat control. In a field-trial, 1080-poisoned hen eggs reduced stoat consumption of eggs by 92% and the number of stoats caught in traps by 87%. Diphacinone-poisoned hen eggs reduced stoat consumption of eggs by 86% and the number of stoats caught in traps by 83% in one field-trial, and stoat consumption of eggs by 86% in a second field-trial. Recommendations are made for managers intending to use poison-baiting for stoat control and on further research needed to improve the efficacy of baits for stoat control.

Spurr, E.B. 1999: Developing a long-life toxic bait and lures for mustelids. *Science for Conservation 127A*: 1–24.

or in full as:

Spurr, E.B. 1999: Developing a long-life toxic bait and lures for mustelids. Pp. 1–24 in: Department for Conservation 1999: Progress in mammal pest control on New Zealand conservation lands. *Science for Conservation 127*, x + 74 p.

1. Introduction

Of three species of mustelids in New Zealand, stoats (*Mustela erminea*) are the most abundant and widespread and the greatest threat to conservation. Stoat predation is an important factor in the continued decline of several bird species, such as brown kiwi (*Apteryx australis*), black stilt (*Himantopus novaezelandiae*), New Zealand dotterel (*Charadrius obscurus*), kaka (*Nestor meridionalis*), yellow-crowned kakariki (*Cyanoramphus auriceps*), and yellowhead (*Mohoua ochrocephala*) (Dowding and Murphy 1996, Elliott et al. 1996, McLennan et al. 1996, O'Donnell 1996, O'Donnell et al. 1996). The Department of Conservation (DOC) currently uses Fenn traps in tunnels baited with domestic hen eggs as the main method of stoat control for protection of these species (King et al. 1994). However, trapping is labour-intensive because, by law, traps must be checked daily. Furthermore, traps and tunnels are bulky and heavy, and so are difficult to move from one area to another. Consequently, trapping is currently restricted to small, localised areas. An attractive and long-lasting bait incorporating a toxicant is urgently needed as an alternative to trapping for large-scale stoat control.

Hence the objective of the present study was to develop a long-life toxic bait which is attractive and palatable to mustelids, by:

- Comparing the palatability of different bait types.
- Evaluating the use of lures to increase the attractiveness of baits.
- Determining the toxicity of baits incorporating acceptable toxicants.
- Demonstrating the efficacy of toxic baits in field-trials.

2. Methods

2.1 PALATABILITY OF BAITS TO STOATS

The palatability of different baits was determined for wild-caught stoats housed individually in small cages at least 1 m ´ 1 m ´ 0.5 m, or in a large observation pen approximately 10 m ´ 6 m ´ 3 m, at the Landcare Research animal facility. The stoats were maintained on a diet of raw beef or horsemeat (males receiving 80 g, females 50 g), raw domestic hen eggs (one each), and dead day-old domestic chickens (one each), on alternating nights, with water *ad libitum*. They were acclimatised to captivity for at least 4 weeks before being used in any tests.

The relative palatability of raw horsemeat, whole raw hen eggs, punctured raw hen eggs, and dead day-old chickens was determined for seven stoats (three males and four females) in April 1992. Each stoat was offered a choice of similar amounts of two food types per night, one in each half of a two-compartment food dish (randomly allocated to left or right). The combination of food types and order of presentation to each stoat was also randomised, so that each stoat received each food type twice. The

amount of each food type eaten by the stoats was calculated from the weight of the food remaining at the end of each test, and compared by analysis of variance (SPSS Inc. 1996). No correction was made for any natural changes in weight of food, which were considered to be negligible. In subsequent tests, stoats were offered raw beef, boiled hen eggs, a choice of quail eggs and hen eggs, and a choice of dead day-old chickens and dead mice (*Mus musculus*). Direct observations were made of some tests and time-lapse video recordings of others.

The relative palatability of a range of potential long-life baits and other food materials that might be incorporated into baits (listed with food items in Table 1) was screened against the same seven stoats as above from April 1992 to December 1993. A known weight of one bait type (approx. 50 g) was presented in one-half of a two-compartment food dish, with raw horsemeat (approx. 50 g) in the other half (randomly allocated to left or right). The amount of each bait eaten by stoats was calculated from the amount of bait remaining at the end of each test. No correction was made for any natural changes in bait weight. At least 1 day without baits was allowed between tests. Because of the large number of potential bait materials, some were tested on only two stoats. Statistical comparisons of the palatability of different bait types were not attempted.

The palatability of two baits was tested on a further 12 captive stoats (of mixed sex) in 1994/95. Canned sardine-in-aspic cat-food (Wondercat, Pataya Food Industries, Samutsakorn, Thailand) was offered to the stoats on 20 June, 27 June, and 4 July 1994. The stoats were offered a known weight (approx 50 g) of bait plus one whole raw hen egg for 1 night in each trial. Three samples of cat-food were placed outside the stoat pens for measurement of natural weight change from dehydration. The amount of cat-food eaten by stoats was calculated from the weight of the cat-food remaining, corrected for dehydration, at the end of each test.

PussOff® (Applied Biotechnologies Pty Ltd, Brooklyn, Australia), a non-toxic, long-life bait, developed as a trial bait for control of cats (*Felis catus*), was offered to the same 12 captive stoats as above. Each stoat was offered one bait (about 30 g) plus about 50 g of their normal raw meat diet. So-called ‘rodent-flavoured’ baits were offered on 24 July, ‘bird-flavoured’ ones on 27 July, and ‘basic’ ones on 31 July, each time for 3 nights. ‘Rodent-flavoured’ baits were offered again for 3 nights on 7 August. This sequence of testing was not suitable for discriminating between bait flavours because of possible neophobia by stoats and a possible effect of order of presentation of bait flavours. To discriminate between flavours, the stoats were offered a choice of all three flavours (one bait of each) plus their normal raw meat diet for 1 night on 14 August. One sample of each bait type was placed outside the stoat pens for measurement of natural weight change. The amount of each type of flavoured bait eaten by stoats was calculated from the weight of the bait remaining, corrected for dehydration, at the end of each test, and compared by analysis of variance.

2.2 LURES FOR STOATS

Olfactory lures include foods and baits as well as scents and flavours. The luring power of acceptable food items (dead mice, dead day-old chickens, raw horsemeat, and raw hen eggs), and also peanut butter, was determined for seven captive stoats (three males and four females) by placing the items under perforated opaque plastic

domes so that the stoats could smell them but not see them. Each stoat was exposed to the smell of each food type once, for 24 hours, in random order. The stoats received their normal diet of raw horsemeat at the same time. The percentage of stoats that overturned the plastic domes to obtain the hidden food item was calculated for each food type. With n = 7 stoats, there is an 80% chance, at the 95% level of statistical probability, of discriminating an 80% difference in attractiveness of lures (e.g. between 100% and 20% of stoats being attracted to lures) if a difference exists (Elashoff 1997).

The ability of olfactory lures other than foods and baits (viz., odours) to attract stoats was determined for the same seven stoats as above. Odours tested included weasel lure, fisher lure, muskrat musk, and musk amberette used by fur trappers in North America (S. Stanley Hawbaker & Sons, Fort Loudon, U.S.A.), acetamide (which has a mousy odour), trimethylamine (synthetic meat odour), isopentenyl methyl sulfide (synthetic mustelid anal gland secretion), synthetic fermented egg (Bullard et al. 1978), chicken flavour (Firmenich), and chicken, fish, liver, lobster, and meat flavours or aromas used in the food industry (Bush Boake Allen, Auckland, New Zealand). One drop of test substance was absorbed into a 20-cm square of sponge or a cotton-wool ball and placed under a perforated opaque plastic dome as above. Stoats were exposed to the odours in random order, once for 24–72 hours. They received their normal diet of raw horsemeat at the same time. Because of the large number of potential odours, some were tested on only two stoats. The percentage of stoats that overturned the plastic domes to investigate the hidden odour was calculated for each odour type. With n = 2 stoats, it is not statistically possible to discriminate between both stoats being attracted and neither stoat being attracted to lures. However, for this investigation, if neither stoat was attracted to a lure, the lure was considered unattractive.

The ability of flavours to enhance bait consumption was determined for the same seven stoats as above by adding flavours to gelatine and water to make a jelly bait. The flavours tested were 2% chicken, 2% fish, 2% liver, 2% and 10% meat flavours or aromas (Bush Boake Allen, Auckland, New Zealand) and 10% egg powder (Cuddon and Stewart Ltd, Christchurch, New Zealand). Each stoat was offered one bait at a time, in addition to the normal diet of raw horsemeat, in a two-compartment food dish (randomly allocated to left or right). The order of presentation of baits to each stoat was randomised, so that over a period of 1 month each stoat received each bait type twice. One sample of each bait was placed outside the stoat pens for measurement of natural weight change from dehydration. The amount of each bait type eaten by stoats was calculated from the weight of the bait remaining at the end of each test, corrected for dehydration.

2.3 TOXICANTS FOR STOAT CONTROL

Three chemicals were tested for toxicity to captive stoats; sodium monofluoroacetate (1080), diphacinone, and cholecalciferol.

2.3.1 1080

Sodium monofluoroacetate (compound 1080) is registered in New Zealand for the control of brushtail possums (*Trichosurus vulpecula*), rabbits (*Oryctolagus cuniculus*), and cats, but because of its high toxicity it can be used only by licensed

operators. Animals normally die within a few hours of eating a lethal dose. The acute LD_{50} for the Norway rat (*Rattus norvegicus*) is 0.2–3.0 mg/kg, and for the ferret (*Mustela furo*) it is 1.2–1.4 mg/kg (Eisler 1995).

The toxicity of 1080 to stoats was determined by offering captive stoats raw hen eggs injected with 1080 dissolved in water. An egg containing the equivalent of 0.25 mg of 1080 per kg of stoat body weight was given to one female, 0.5 mg/kg to one female and one male, 0.75 mg/kg to one female, 1.0 mg/kg to one female, 1.5 mg/kg to two males, 2.0 mg/kg to one male, and 2.5 mg/kg to two males. Non-toxic eggs were given to one female and one male. The fate of the stoats was recorded 12 hours later, and the LD_{50} (dose lethal to 50% of the population) and LD_{90} (dose lethal to 90% of the population) calculated using a maximum likelihood estimate (SPSS Inc. 1996).

2.3.2 Diphacinone

Diphacinone is a first-generation anticoagulant, and has an experimental use registration in New Zealand for rodent and rabbit control. It can be used by the public, and has an antidote (vitamin K). Death normally occurs 7–14 days after animals eat a lethal dose. The acute LD_{50} for the Norway rat is 2.3–43 mg/kg (Buckle 1994). However, the acute LD_{50} for the Indian mongoose (*Herpestes auropunctatus*) is only 0.13 mg/kg (J.O. Keith, D.N. Hirata, and D.L. Espy unpubl. data).

The toxicity of diphacinone to stoats was determined by offering captive stoats raw hen eggs injected with diphacinone dissolved in propylene glycol. An egg containing 0.025 mg of diphacinone was given to one male, 0.05 mg to one female, 0.1 mg to one male, 0.2 mg to one male, 0.4 mg one male, 0.8 mg one female, 1.6 mg to one female, and 3.2 mg to one female and one male. These amounts of diphacinone are equivalent to about 0.1–16 mg/kg stoat body weight. Non-toxic eggs, injected with propylene glycol only, were given to one female and one male. The fate of the stoats was recorded daily for at least 28 days. Dead stoats were autopsied for signs of anticoagulant poisoning. An LD_{50} and LD_{90} were not calculated because of insufficient data.

2.3.3 Cholecalciferol

Cholecalciferol was developed as a rodenticide, and is registered in New Zealand for possum control. Animals normally take several days to die, but the compound has a stop-feeding action after about 24 hours. The acute LD_{50} for rats is 352–619 mg/kg (Eason 1991).

The toxicity of cholecalciferol to stoats was determined by offering stoats hen eggs injected with 30 mg, 50 mg, or 100 mg of cholecalciferol dissolved in corn oil. An egg containing 30 mg of cholecalciferol was given to one female and one male, 50 mg to five males, and 100 mg to one female and one male, equivalent to approximately 150, 250, and 500 mg/kg body weight, respectively. Non-toxic eggs, injected with corn oil only, were given to one female and one male. The fate of the stoats was recorded daily for at least 28 days. An LD_{50} and LD_{90} were not calculated because of insufficient data.

2.4 FIELD EFFICACY OF TOXIC BAITS

2.4.1 1080 in hen eggs

The efficacy of 1080 in hen eggs was field-tested in Craigieburn Forest Park in February–April 1994. The poison area was in the Craigieburn River valley and the non-poison area was in the Broken River valley. The two valleys were at least 2 km apart, with a 1500-m ridge between them. Thirty-eight bait stations (wooden cantilever live-traps with the treadle locked half open) were placed 100 m apart in a single line in each valley. Two non-toxic hen eggs were placed in each bait station on 14 February 1994, and replaced as necessary at 1–5-day intervals until 15 March 1994. Initially, the entrances to the bait stations were 90 mm ´ 60 mm to exclude entry by non-target animals such as possums, Australasian harriers (*Circus approximans*), and kea (*Nestor notabilis*), but after 5 March they were restricted to 35 mm ´ 60 mm, large enough to allow entry by stoats but small enough to prevent them removing the eggs and leaving them outside exposed to non-target species. One egg injected with 0.3 mg of 1080 (in 0.6 ml of aqueous solution) was placed in each bait station in the poison area on 15 March and replenished as necessary until 6 April 1994. Toxic eggs were dyed green (Spurr and Hough 1997). One non-toxic egg was placed in each bait station in the non-poison area at the same time. A video camera and time-lapse recorder were set up at bait stations, illuminated by infrared light, for 9 nights to record visiting animals. The treadles on the 38 wooden cantilever live-traps in each valley were unlocked, and the traps baited with non-toxic hen eggs, on 6 April 1994. The traps were checked daily until 9 April 1994, when trapping ceased.

The effectiveness of poison-baiting was assessed by comparing the stoat population in the poison area before and after poison-baiting with that in the non-poison area monitored at the same time. The stoat populations were estimated in two ways. One index of stoat numbers was calculated from the average number of eggs per day eaten by stoats. This assumes that egg consumption by stoats is proportional to stoat numbers. Thus:

Percentage reduction = (1 – O/E) ´ 100

where O is the observed number of eggs eaten in the poison area post-poison, and E is the expected number if there had been no reduction. E was calculated from (A/B) ´ C, where A is the number of eggs eaten in the poison area pre-poison, B is the number of eggs eaten in the non-poison area pre-poison, and C is the number of eggs eaten in the non-poison area post-poison. It was not possible to calculate confidence limits around the percentage reduction because there was only one line of bait stations.

A second estimate of the stoat populations was calculated from the number of stoats trapped in the poison and non-poison areas after poison-baiting. Stoats were not trapped before poison-baiting, but the ratio of the average number of eggs per day eaten by stoats in the two areas before poison-baiting was used to estimate the number of stoats that would be expected to be trapped in the poison area post-poison if there had been no reduction from poison-baiting. Because there was no replication, the results of this analysis apply only to this trial.

2.4.2 Diphacinone in hen eggs

The efficacy of diphacinone in hen eggs was tested in two field-trials, one in collaboration with S. Phillipson, Canterbury Conservancy, and one in collaboration with G. Loh, Otago Conservancy, in 1994/95.

In the Canterbury trial, the poison area was in the valley of the Hawdon River, and the non-poison area was in the valley of the Waimakariri River. The two areas were 1 km apart, with the Hawdon River between them. Fifty bait stations (wooden tunnels) were placed at 100-m intervals along a line in both areas. Non-toxic hen eggs (one whole and one punctured) were placed in the bait stations on 24 November 1994 and replaced as necessary at 2–7 day intervals until 19 January 1995. During this time stoats were able to remove the eggs from the bait stations. On 19 January 1995, the entrances to the bait stations were restricted to a circular hole of 43-mm diameter to prevent stoats removing the eggs. Non-toxic hen eggs (one whole and one punctured) were then placed in the bait stations and replaced as necessary at 2–3 day intervals for a further 10 days (until 29 January 1995). Two hen eggs injected with 3.75 mg of diphacinone (in 0.75 ml of propylene glycol solution) were placed in bait stations in the poison area on 29 January, and replaced as necessary at 2–4 day intervals until 13 February 1995. Non-toxic hen eggs continued to be placed in bait stations in the non-poison area until 13 February 1995. Fenn traps baited with non-toxic hen eggs were set in the tunnels in both areas on 13 February and checked and re-set daily until 18 February 1995. The effectiveness of poison-baiting was assessed using the same two methods as above.

In the Otago trial, the poison and non-poison areas were 5 km apart in the Caples River valley. Sixty bait stations (aluminium tunnels) were placed at 100-m intervals on a grid of six lines of 10 bait stations in both areas. Non-toxic hen eggs (one whole and one punctured) were placed in all bait stations on 3 December 1994 and replaced as necessary at 2–10 day intervals until 1 February 1995. During this time stoats were able to remove the eggs from the bait stations. On 1 February 1995, the entrances to the bait stations were restricted to a hole of 57 mm ´ 38 mm to prevent stoats removing the eggs. Non-toxic hen eggs (one whole and one punctured) were then placed in bait stations and replaced as necessary at 2-day intervals for a further 6 days (until 7 February 1995). Two hen eggs injected with 3.75 mg of diphacinone (in 0.75 ml of propylene glycol solution) were placed in bait stations in the poison area on 7 February, and replaced as necessary at 2–4 day intervals until 3 March 1995. Non-toxic hen eggs continued to be placed in bait stations in the non-poison area and checked and replaced as necessary at 2–4 day intervals until 3 March 1995. Fenn traps baited with non-toxic rabbit meat were set in the tunnels in the non-poison area on 8 March and checked and re-set daily until 12 March 1995. Traps were not set in the poison area. Thus, the effectiveness of poison-baiting could only be assessed by comparing egg consumption in the two areas before and after poison-baiting, using the same method as above.

3. Results

3.1 PALATABILITY OF BAITS TO STOATS

The maintenance-diet items (dead day-old chickens, raw horsemeat, whole raw hen eggs, and punctured raw hen eggs) were eaten by stoats in significantly different amounts ($F_{3,24} = 8.587$, $P < 0.001$) (Table 1). Only dead day-old chickens were always all eaten. However, there was no significant difference between the amount of dead

TABLE 1 PALATABILITY OF FOOD ITEMS AND POTENTIAL BAIT MATERIALS PRESENTED TO CAPTIVE STOATS.

FOOD OR BAIT TYPE	NUMBER OF STOATS	% STOATS EATING FOOD OR BAIT	AMOUNT EATEN (g) PER STOAT PER NIGHT
beef (raw)	7	100	44
beef (raw)/gelatine mixture	7	100	28
beef stock (Oxo cube)	2	0	0
cat bait (Du Pont fish meal)	6	50	4
cat bait (PussOff®)	3	67	11
cat biscuit (Biscats)	2	0	0
cat biscuit (Go-Cat beef, seafood, tuna, & sardine)	4	25	3
cat biscuit (Go-Cat chicken, prawn, turkey, & pilchard)	2	0	0
cat biscuit (Whiskettes beef, lamb, & rabbit)	2	0	0
cat biscuit (Whiskettes chicken & turkey)	6	33	4
cat biscuit (Whiskettes prawn & sardine)	2	50	2
cat-food (canned WonderCat sardine in aspic jelly)	2	100	34
cat-food (canned Chef chicken and turkey casserole)	5	100	38
cheese (cheddar)	3	67	34
chicken (dead day-old)	7	100	50
chicken stock (Oxo cube)	2	0	0
dog biscuit (Bonny)	2	50	1
dog biscuit (Roly's chicken)	4	0	0
dog biscuit (Rover fish enriched)	2	0	0
dog biscuit (Tux)	2	0	0
egg (whole raw hen's)	7	71	21
egg (punctured raw hen's)	7	100	30
egg (whole boiled hen's)	6	67	25

TABLE 1 (CONTINUED)

FOOD OR BAIT TYPE	NUMBER OF STOATS	% STOATS EATING FOOD OR BAIT	AMOUNT EATEN (g) PER STOAT PER NIGHT
egg (broken boiled hen's)	3	100	32
egg (whole raw quail's)	2	100	20
egg (broken raw hen's)/gelatine mixture	7	100	28
egg powder/water dough	6	100	19
fat (beef)	2	50	3
fish-meal/water dough	2	50	9
fish-meal dried pellet (Salmon Services Ltd)	6	50	2
gelatine/water jelly (unflavoured)	2	100	42
golden syrup	2	0	0
honey	2	0	0
horsemeat (raw)	7	100	45
icing sugar/water	2	0	0
jam (Craig's raspberry)	2	0	0
Kremelta	2	0	0
Marmite	2	0	0
molasses	2	0	0
mouse (dead)	2	100	20
peanut butter	6	71	10
petroleum jelly	2	0	0
possum bait (AgTech)	2	0	0
possum bait (Waimate RS5)	2	0	0
possum bait (Wanganui No. 7)	2	0	0
rat bait (Talon 20P)	2	0	0
rat bait (Talon 50WB)	7	0	0
rat bait (Waxy Pack)	2	0	0

day-old chickens and raw horsemeat eaten (Bonferroni pairwise probability > 0.05). Punctured raw hen eggs were eaten significantly less than dead day-old chickens (but not horsemeat), while whole raw hen eggs were eaten significantly less than both dead day-old chickens and raw horsemeat (Bonferroni pairwise probabilities < 0.05). Although not compared statistically, raw beef was eaten in similar amounts to raw horsemeat, and boiled hen eggs were eaten in similar amounts to raw hen eggs.

Of the potential bait materials other than maintenance-diet items offered to stoats, dead mice, quail eggs, canned cat-foods, gelatine, cheese, egg powder, peanut butter, and PussOff® baits had at least 10 g eaten per stoat (Table 1). Only dead mice were all eaten. Dead mice were always taken before dead day-old chickens when they were

TABLE 2 CONSUMPTION OF CANNED SARDINE-BASED CAT-FOOD, IN ADDITION TO NORMAL FOOD, BY CAPTIVE STOATS (N = 12) IN THREE TRIALS (20 JUNE–4 JULY).

DATE	% STOATS THAT ATE BAIT	AMOUNT EATEN (g) PER STOAT/NIGHT ± STANDARD ERROR
20 June	83	27.1 ± 5.1
27 June	67	17.1 ± 6.3
4 July	75	18.9 ± 5.4

TABLE 3 CONSUMPTION OF PUSSOFF® BAIT, IN ADDITION TO NORMAL FOOD, BY CAPTIVE STOATS (N = 12) WHEN NO CHOICE OF BAIT FLAVOUR (24 JULY–7 AUGUST).

DATE	BAIT FLAVOUR	% STOATS THAT ATE BAIT	AMOUNT EATEN (g) PER STOAT/NIGHT ± STANDARD ERROR
24 July	rodent	17	1.7 ± 0.9
27 July	bird	50	3.9 ± 1.3
31 July	basic	50	5.0 ± 1.5
7 August	rodent	58	6.7 ± 1.4

TABLE 4 CONSUMPTION OF PUSSOFF® BAIT, IN ADDITION TO NORMAL FOOD, BY CAPTIVE STOATS (N = 12) WHEN GIVEN A CHOICE OF BAIT FLAVOURS (14 AUGUST).

BAIT FLAVOUR	% STOATS THAT ATE BAIT	AMOUNT EATEN (g) PER STOAT PER NIGHT ± STANDARD ERROR
rodent	58	5.7 ± 2.1
bird	42	2.9 ± 1.5
basic	33	2.9 ± 1.6
Total	58	11.4 ± 4.5

offered together. Video-recordings showed that stoats collected dead mice soonest (8 min) after being put out, followed by dead day-old chickens (10 min), raw meat (20 min), and raw hen eggs (43 min). Most of the dry, potential long-life, baits offered to stoats were not eaten at all (e.g. rat and possum baits) or were only nibbled at by some stoats (e.g. Du Pont cat baits, Salmon Services fishmeal pellets, and some commercial cat and dog biscuits).

In the trial with canned sardine-based cat-food, 12 captive stoats (of mixed sex) ate an average of 19.7 (± 4.6) g of bait, in addition to the normal food (Table 2). However, two of the stoats (sex unknown) did not eat the cat-food on any of the three occasions it was offered.

TABLE 5 ATTRACTIVENESS OF ODOURS TO CAPTIVE STOATS.

ODOUR	STOATS TESTED	% STOATS ATTRACTED TO ODOUR
acetamide	5	0
chicken (raw)	7	100
chicken aroma (Bush Boake Allen)	2	0
chicken flavour (Firmenich)	2	0
egg (raw hen's)	7	100
egg (synthetic fermented)	5	20
fish flavour (Bush Boake Allen)	2	0
fisher lure (Hawbaker's)	4	25
isopentenyl methyl sulfide	7	0
liver flavour (Bush Boake Allen)	2	0
lobster flavour (Bush Boake Allen)	2	0
meat (raw horse)	7	100
meat aroma (Bush Boake Allen)	2	0
mouse (dead)	7	100
muskrat musk (Hawbaker's)	2	0
musk amberette (Hawbaker's)	2	0
peanut butter	7	57
trimethylamine	2	0
weasel lure (Hawbaker's)	4	25

TABLE 6 CONSUMPTION OF FLAVOURED AND UNFLAVOURED JELLY BAIT, IN ADDITION TO NORMAL FOOD, BY CAPTIVE STOATS (n = 7).

FLAVOUR	% STOATS EATING BAIT	AMOUNT EATEN (g) PER STOAT/NIGHT ± STANDARD ERROR
none	100	15.1 ± 4.3
2% chicken aroma	14	4.5 ± 1.8
10% egg powder	100	18.2 ± 6.3
2% fish flavour	43	11.0 ± 6.2
2% liver flavour	71	3.2 ± 1.2)
2% meat aroma	100	7.1 ± 1.8
10% meat aroma	43	3.5 ± 1.9

TABLE 7 FATE OF CAPTIVE STOATS FED HEN EGGS INJECTED WITH 1080.

AMOUNT OF 1080 (mg/kg BODY WEIGHT)	SEX OF STOAT	WEIGHT OF STOAT (g)	FATE OF STOAT
0.0	F	217	Survived
	M	356	Survived
0.25	F	202	Survived
0.5	F	243	Died
	M	371	Survived
0.75	F	221	Died
1.0	F	220	Died
1.5	M	326	Died
	M	312	Died
2.0	M	365	Died
2.5	M	367	Died
	M	361	Died

In the trial with PussOff® baits, the number of stoats eating baits and the amount of bait eaten increased with repeated exposure to baits (Table 3). Rodent-flavoured baits were eaten significantly less when first offered than when offered a second time (paired $t_{11} = -3.724$, $P = 0.003$). Presumably, this was a reaction by stoats to a new food type. PussOff® was eventually eaten by 7 of the 12 stoats offered the baits, and those 7 ate all the bait offered (30 g each).

Two of the stoats that did not eat any PussOff® bait were the same two that did not eat any canned sardine-based cat-food (above). In the choice trial (Table 4), there was no significant difference between the amounts of the different-flavoured PussOff® baits eaten ($F_{2,33} = 0.833$, $P = 0.444$).

3.2 LURES FOR STOATS

All seven captive stoats tested were attracted to the odour of dead mice, dead chickens, raw horsemeat, and raw whole hen eggs under perforated opaque plastic domes (Table 5). Peanut butter also attracted four of the seven stoats. Weasel lure, fisher lure, and synthetic fermented egg were investigated by one stoat. None of the other artificial odours or flavours tested attracted any stoats.

Addition of various flavours to gelatine-based jellies did not appear to enhance consumption of the jellies by stoats (Table 6).

3.3 TOXICANTS FOR STOAT CONTROL

3.3.1 1080

One stoat (a male) that ate an egg containing 0.5 mg of 1080 per kg body weight survived and the other (a female) died within 12 hours (Table 7). All seven stoats that ate 0.75 mg/kg or more died within 12 hours. The LD_{50} was estimated as 0.49 mg/kg (with 95% confidence limits of 0.29–0.70 mg/kg) and the LD_{90} as 0.70 mg/kg (with 95% confidence limits of 0.47–0.87 mg/kg).

3.3.2 Diphacinone

The seven stoats (three females and four males) that ate eggs containing 1.6 mg of diphacinone or less all survived (Table 8). The two stoats (one female and one male) that ate eggs containing 3.2 mg of diphacinone died after 7 and 10 days, respectively. They did not eat any food for 2 days before their death.

3.3.3 Cholecalciferol

Six of the stoats (one female and five males) that ate eggs containing cholecalciferol stopped feeding after 1 day, but two (one female and one male) did not stop feeding until after 5 days (Table 9). The two that ate the lowest amount (30 mg) of cholecalciferol took the longest to die. Both stopped feeding for 3 days then resumed feeding again until they died after 20–27 days. Six of the seven stoats that ate 50–100 mg of cholecalciferol died after 5–14 days. One stoat that (supposedly) ate 50 mg of cholecalciferol stopped feeding after 10 days, for 2 days, but recovered and survived.

TABLE 8 FATE OF CAPTIVE STOATS FED HEN EGGS INJECTED WITH DIPHACINONE.

DIPHACINONE (mg/STOAT)	SEX OF STOAT	WEIGHT OF STOAT (g)	FATE OF STOAT	DAYS TO DEATH
0.0	F	205	Survived	–
	M	358	Survived	–
0.025	M	316	Survived	–
0.05	F	171	Survived	–
0.1	M	297	Survived	–
0.2	M	370	Survived	–
0.4	M	280	Survived	–
0.8	F	170	Survived	–
1.6	F	175	Survived	–
3.2	F	198	Died	7
3.2	M	277	Died	10

TABLE 9 FATE OF CAPTIVE STOATS FED HEN EGGS INJECTED WITH CHOLECALCIFEROL.

CHOLECALCIFEROL (mg/STOAT)	SEX OF STOAT	WEIGHT OF STOAT (g)	FATE OF STOAT	DAYS TO DEATH	DAYS TO STOP FEED
0	F	219	Survived	–	–
	M	371	Survived	–	–
30	F	159	Died	20	5
	M	241	Died	27	1
50	M	278	Survived	–	(10)
	M	285	Died	5	1
	M	320	Died	6	5
	M	333	Died	6	1
	M	309	Died	14	1
100	F	211	Died	7	1
	M	230	Died	13	1

3.4 FIELD EFFICACY OF TOXIC BAITS

3.4.1 1080 in hen eggs

In the 10 days before poison-baiting began in the Craigieburn valley (15 March 1994), stoats ate an average of 6.4 eggs/day (or 16.8% of the eggs available) in the poison area and 5.7 eggs/day (or 15.0% of the eggs available) in the non-poison area (Fig. 1). From 26 to 31 March (11–16 days after poison-baiting began), the number of eggs eaten by stoats declined sharply in the poison area but not in the non-poison area. From 5 to 6 April (22 days after 1080-poisoned eggs were first put out), stoats ate one 1080-poisoned egg in the poison area and 11 non-toxic eggs in the non-poison area. After correcting for the difference in the number of eggs eaten by stoats in the two areas before 1080-poisoning, this represents a 91.9% reduction in the number of eggs eaten in the poison area relative to the non-poison area.

The live-traps set from 7 to 9 April, inclusive, caught one stoat (a 251-g male) in the poison area and eight stoats (three males and five females) in the non-poison area (Table 10). If it is assumed that stoat densities in the two areas were similar before poison-baiting, then, after correcting for the number of trap nights, the percentage reduction in the number of stoats caught in the poison area was 85.7%. If an adjustment is made for differences in the mean pre-poison number of eggs per day eaten by stoats in the poison and non-poison areas, then the percentage reduction in the number of stoats caught in the poison area was 87.3%. The average weight of the males caught was 236 g (range 228–251 g) and females 173 g (range 145–195 g).

Video-recordings showed stoats, a possum, and a kea approaching bait stations, but only stoats entered and ate the eggs (Table 11). Mice were not recorded on video-tape but one mouse was caught in a live-catch trap set for stoats. Rats were not known to be present nor were they caught in the study areas. Stoats did not appear to be afraid of entering the bait stations. On 26 February, before the entrances to the bait stations were restricted in size, one stoat was recorded on video entering a bait station at 0800 hours and using its nose to roll a non-toxic egg away. This was less than 2 min after the bait station had been checked. Fifteen minutes later the stoat returned and rolled the

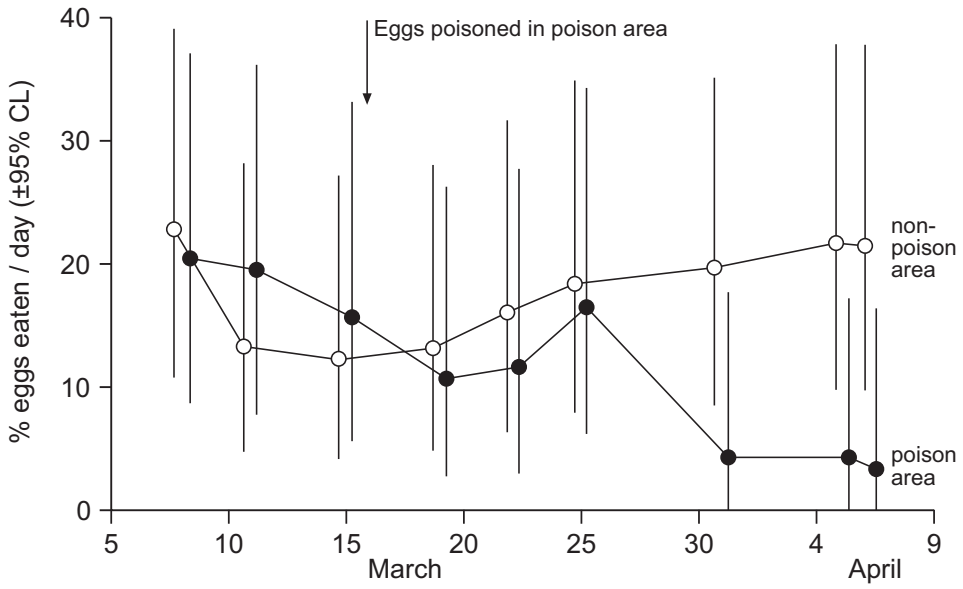

FIGURE 1
PERCENTAGE OF HEN EGGS EATEN INSIDE BAIT STATIONS BY STOATS IN CRAIGIEBURN FOREST PARK, MARCH-APRIL 1994 (±95% BINOMIAL CONFIDENCE LIMITS).

TABLE 10 STOATS TRAPPED IN THE POISON AREA (92 TRAP NIGHTS) AND NON-POISON AREA (105 TRAP NIGHTS) IN CRAIGIEBURN FOREST PARK, 7–9 APRIL 1994.

	POISON AREA				NON-POISON AREA			
	NIGHT 1	NIGHT 2	NIGHT 3	TOTAL	NIGHT 1	NIGHT 2	NIGHT 3	TOTAL
Males	0	1	0	1	3	0	0	3
Females	0	0	0	0	2	1	2	5
Total	0	1	0	1	5	1	2	8

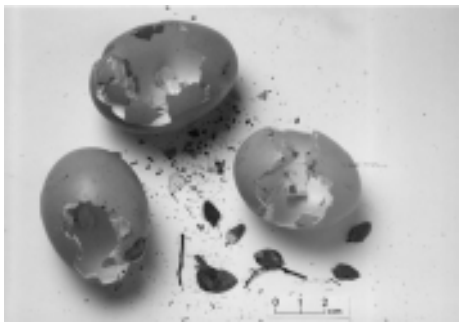

FIGURE 2 REMAINS OF SHELLS OF HEN EGGS EATEN BY STOATS.

second egg away. On 27 February, a stoat was video-recorded entering a bait station at 0650 hours and carrying an egg away in its mouth, then returning 15 min later and carrying away the second egg. The stoat left with the second egg less than 2 min before the bait station was checked. After 5 March, when the entrances to the bait stations were restricted to prevent eggs being removed, stoats ate the eggs inside the bait stations. The egg contents were almost always completely eaten, through irregular-shaped holes made in the egg shells (Fig. 2). The remains of these egg shells were indistinguishable from the remains of egg shells left by captive stoats.

TABLE 11 VIDEO-RECORDINGS OF ANIMALS VISITING BAIT STATIONS IN CRAIGIEBURN FOREST PARK, FEBRUARY-APRIL 1994. (DATES WITH AN ASTERISK ARE BEFORE BAIT STATION ENTRANCES WERE RESTRICTED IN SIZE TO PREVENT EGGS BEING REMOVED. KEA AND POSSUM DID NOT ENTER THE BAIT STATIONS.)

DATE	VISITORS	EGGS EATEN
26 February*	stoat	2/2
27 February*	stoat	2/2
4 March*	none	0/1
5 March	none	0/1
22 March	stoat	1/1
31 March	stoat	1/1
4 April	none	0/1
5 April	kea	0/1
6 April	stoat, possum	1/1

3.4.2 Diphacinone in hen eggs

In 10 days (20–29 January 1995) before poison-baiting began in the Hawdon River valley, stoats ate 16.7 eggs/day (or 16.7% of the eggs available) in the poison area, and 25.8 eggs/day (or 25.8% of the eggs available) in the non-poison area (Fig. 3). By 7 February (9 days after poison-baiting began), the number of eggs eaten by stoats in the poison area had declined sharply in the poison area but not in the non-poison area. On 13 February (15 days after poisoned eggs were first put out) the number of eggs eaten by stoats had declined by 85.6% in the poison area relative to the non-poison area. A female stoat with extensive internal haemorrhaging, characteristic of anticoagulant poisoning, was found dead in the poison area 14 days after poison-baiting began. Traps set for 5 nights (250 trap/nights) in each area after poison-

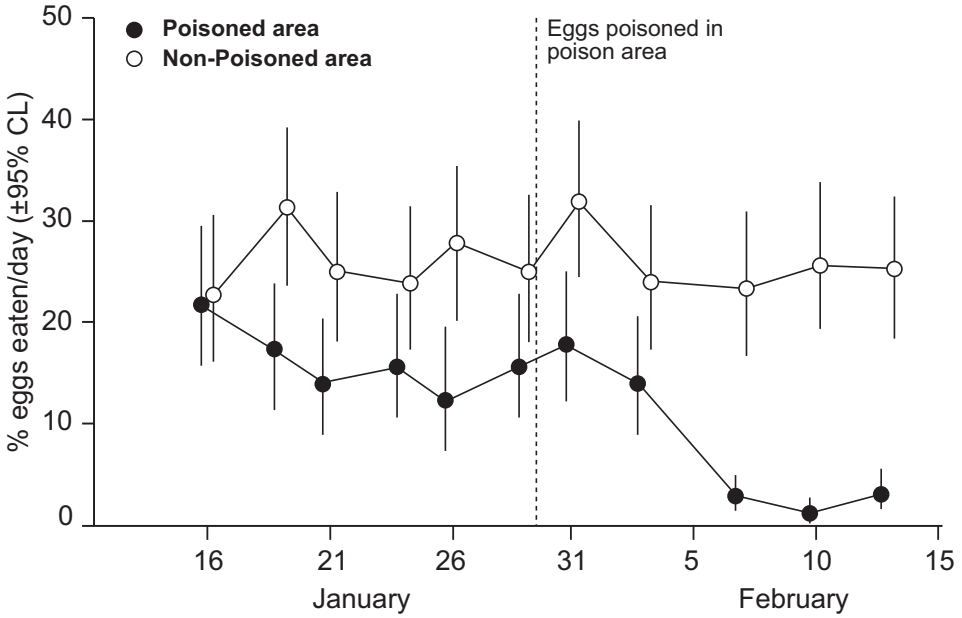

FIGURE 3 PERCENTAGE OF HEN EGGS EATEN INSIDE BAIT STATIONS BY STOATS IN THE HAWDON AND WAIMAKARIRI VALLEYS, JANUARY-FEBRUARY 1995 (± 95% BINOMIAL CONFIDENCE LIMITS).

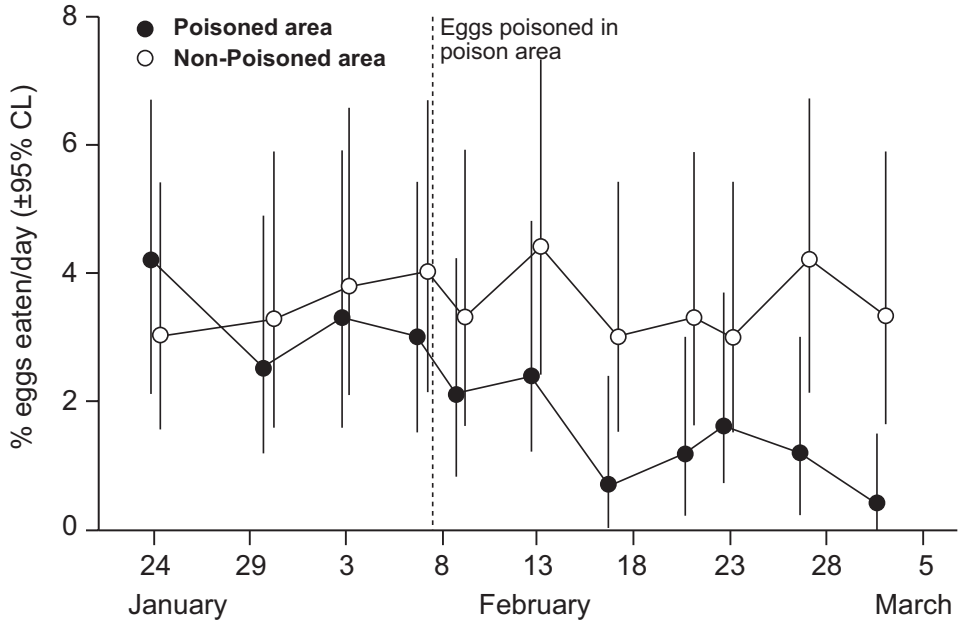

FIGURE 4 PERCENTAGE OF HEN EGGS EATEN INSIDE BAIT STATIONS BY STOATS IN THE POISON AND NON-POISON AREAS, CAPLES VALLEY, JANUARY-MARCH 1995 (± 95% BINOMIAL CONFIDENCE LIMITS).

baiting caught two stoats (one female and one male) in the poison area and 18 stoats (10 females and eight males) in the non-poison area. If an adjustment is made for the difference in the number of eggs per day eaten by stoats in the poison and non-poison areas before poison-baiting, then the percentage reduction in the number of stoats caught in the poison area was 82.8%.

In 6 days (2–7 February 1995) before poison-baiting began in the Caples valley, stoats ate 5.0 eggs/day in the poison area, and 5.8 eggs/day in the non-poison area. Ten days after poison-baiting began, the number of eggs eaten by stoats in the poison area had declined by 81.5% relative to the non-poison area (Fig. 4). However, egg consumption in the poison area increased again for the next 6 days, then declined by 86.2% relative to the non-poison area 24 days after poison-baiting. Three stoats were caught in 240 trap/nights from 8 to 12 March in the non-poison area. Traps were not set in the poison area.

4. Discussion

4.1 PALATABILITY OF BAITS TO STOATS

Captive stoats readily ate freshly dead animals (such as mice and day-old chickens), fresh raw meat, and birds eggs, but did not readily eat processed foods or dry long-life baits used for other pests such as rats, cats, and possums. Based on the results of this investigation, the order of preference for the fresh foods tested is dead mice, dead chickens, raw meat (horse or beef), raw quail eggs, broken boiled hen eggs, punctured raw hen eggs, whole boiled hen eggs, whole raw hen eggs, and canned cat-food. Dead mice have been used as baits for a stoat control trial in New Zealand (C.M. King pers. comm.) and for a cat control trial in Australia (Short et al. 1997). The problem with using freshly dead animals or fresh meats as a bait is that they become putrefied after a few days whereas eggs may last for up to 1–2 months. Consequently, until palatable longer-lasting baits are discovered, hen eggs should be used as baits for stoat control. The use of hen eggs as baits for control of pests is not new. For example, hen eggs injected with toxicants have been used as baits for the control of rabid skunks (*Mephitis mephitis*) in the U.S.A. (Seyler and Niemeyer 1974, Rosatte et al. 1986).

One problem with using hen eggs as baits is that stoats do not always eat them. The eggs also appear to be eaten less often by females than by males (Murphy et al. 1992). One solution to this problem may be to use shorter-lasting, more palatable baits (e.g. dead mice, dead chickens, or raw meat) at the same time as eggs in an attempt to increase the proportion of stoats eating baits. However, this creates a new problem; viz., how to prevent stoats removing baits from bait stations and exposing them to non-target species.

Of the remaining bait materials tested, PussOff® cat bait and canned cat-food may be worth further investigation. PussOff® cat bait is no longer commercially available, but an approach could be made to the manufacturer to see whether further development could be undertaken to improve its palatability to stoats, so that all stoats eat the bait. This is the only truly long-life bait that was at all palatable to stoats. Canned cat-foods

are reasonably palatable to stoats—some brands and types appear to be more palatable than others (Murphy et al. 1992, Spurr unpubl. data), and their field-life could be prolonged by the addition of preservatives. PestOff® Ferret Paste (Animal Control Products Ltd, Wanganui, New Zealand) is a fish-based cat-food containing preservatives and 0.03% diphacinone, developed by Landcare Research for ferret control. It is palatable to stoats (Spurr unpubl. data) but has not been tested for efficacy in the field. Cheese and peanut butter also seem worth further investigation as baits, although how long they remain palatable to stoats has not been determined.

Palatability to captive stoats may not be the same as palatability to wild stoats. Knowledge of the proportion of wild stoats that eat different bait types (e.g. eggs and meat) at different times of the year is needed urgently to improve control efficacy. Iophenoxic acid has been shown to elevate the blood iodine level of stoats (as well as ferrets) and may be suitable as a bait marker for such a study (Ogilvie et al. 1996, Spurr unpubl. data).

4.2 LURES FOR STOATS

The most effective lures for captive stoats in this study were freshly dead animals (such as mice and chickens), fresh meats, and eggs. In a subsequent study, captive stoats visited mouse odour stations more than twice as often and for more than eight times the amount of time as egg odour stations (Spurr unpubl. data). Dilks et al. (1996) caught twice as many stoats in traps baited with dead mice compared to hen eggs, although the difference was not statistically significant. However, when live mice were held in cages beside traps they appeared to deter rather than attract stoats to the traps (Dilks 1997). Further research needs to be done urgently on developing mouse (or other natural food) odours as a lure for stoats.

The artificial odours and flavours tested (e.g. trappers lures, food flavours, trimethylamine, and synthetic fermented egg) were all relatively unattractive to captive stoats in this study. However, only one concentration of these lures was tested. Isopentenyl methyl sulfide, a synthetic component of the anal sac secretion of mustelids, was also unattractive to captive stoats. Other synthetic components of the anal sac secretion of mustelids have also been found to be unattractive to stoats, although attractive to ferrets (Clapperton et al. 1994).

4.3 TOXICANTS FOR STOAT CONTROL

Sodium monofluoroacetate (1080), diphacinone, and cholecalciferol have all been shown to be suitable toxicants for stoat control. All are registered in New Zealand for the control of other vertebrate pests, such as possums, rabbits, and rodents. Other toxicants such as brodifacoum and pindone may also be suitable for stoat control, but have not been tested. The choice of which toxicant to use for stoat control is influenced by a number of factors, such as speed of action and safety of use. The toxicant 1080 is fast-acting, killing stoats within a few hours of eating poisoned baits. However, use of 1080 is restricted to licensed operators because it is highly toxic. Diphacinone is not so restricted, but is slower-acting, so that stoats do not die until 7–10 days after receiving a lethal dose. During this time they may continue to prey on

birds. Cholecalciferol is quicker-acting, generally causing stoats to stop feeding after 1 day, although it does not cause stoats to die until after 5–14 days (or even longer at lower doses). The addition of calcium carbonate to baits may enhance the efficacy of cholecalciferol for stoats, as it does for possums (Jolly et al. 1995).

Estimation of the amount of toxicant required in baits for stoat control is difficult because of the small sample sizes of stoats that have been available for testing. In the case of 1080, the 0.3 mg injected into eggs in the field trial is equivalent to a dose of 1.4 mg/kg for a 207-g female and 0.9 mg/kg for a 324-g male (the average-sized stoats recorded by King and Moody 1982). These values are higher than the estimated LD_{90}. However, 0.3 mg of 1080 per egg is equivalent to a dose of only 0.6 mg/kg for a 482-g male (the largest recorded by King and Moody 1982). This is higher than the estimated LD_{50} but less than the LD_{90}. In recent Department of Conservation trials, only one out of three stoats died after eating eggs containing 0.5 mg of 1080 (equivalent to 1 mg/kg for a 500-g stoat), but all stoats died after eating eggs containing 1 mg of 1080 (equivalent to 2 mg/kg for a 500-g stoat) (Dilks 1997). Consequently, it was recommended that 1 mg of 1080 be injected into eggs for stoat control (Spurr and Hough 1997). The lethal dose of 1080 for stoats appears to be less than that for

TABLE 12 SUMMARY OF POISON-BAITING TRIALS FOR STOAT CONTROL, 1993/94 TO 1996/97.

LOCATION	% REDUCTION IN STOATS	REFERENCE
1080 operations		
Craigieburn 1993/94	92	Present study
Eglinton 1994/95	?	Dilks 1997
Eglinton 1995/96	?	Dilks 1997
Eglinton 1996/97	?	Dilks 1997
Landsborough 1995/96	?	Miller & Elliot 1997
Hurunui 1995/96	?	A. Grant pers. comm.
Hurunui 1996/97	?	King 1997
Okarito 1996/97	100	Miller & Elliot 1997
Diphacinone operations		
Hawdon 1994/95	86	Present study
Caples 1994/95	86	Present study
Waimakariri 1995/96	> 95	Phillipson & Lindores unpubl.
Catlins 1995/96	?	M. Hutchins pers. comm.
Dart 1995/96	?	Dilks 1997
Dart 1996/97	?	Dilks 1997

ferrets (Eisler 1995). There is insufficient data to calculate an LD_{50} or LD_{90} for diphacinone or cholecalciferol. However, 5 mg of diphacinone or 100 mg of cholecalciferol per bait appear to be sufficient to kill stoats.

The amount of 1080 in hen eggs has been shown not to decline for at least 28 days in eggs incubated at temperatures of 15°C and 30°C (Spurr et al. 1996). The amount of diphacinone in hen eggs also did not decline for at least 28 days in eggs incubated at 15°C, but did decline by 20% in 28 days in eggs incubated at 30°C. More diphacinone could be injected into eggs to compensate for this loss. However, eggs are seldom likely to be exposed to temperatures as high as 30°C in bait stations in the field. The stability of cholecalciferol in hen eggs has not been established.

4.4 FIELD EFFICACY OF TOXIC BAITS

The three field trials (one with 1080 and two with diphacinone in hen eggs) resulted in 82–92% reduction in egg consumption, and presumably in the stoat populations, in 2–3 weeks. Success should be even greater in management operations than in these trials because toxic eggs could be left in the field for longer (e.g. from October to May).

Following the success of these trials, the Department of Conservation (DOC) initiated their own trials in 1994/95, 1995/96, and 1996/97, using 1080 in hen eggs in the Eglinton, Hurunui, and Landsborough valleys and in Okarito Forest, and diphacinone in hen eggs in the Hawdon, Waimakariri, and Dart valleys and in the Catlins. However, the results of most of these trials were difficult to interpret (Table 12). Landcare Research was consulted when problems arose, and was commissioned to produce a manual on poison-baiting for stoat control (Spurr and Hough 1997). Advice was also provided to Canterbury, Otago, West Coast, East Coast, and Tongariro-Taupo Conservancies to help them with their stoat control operations. With permission from DOC, information was given to Pest Management Services Ltd to enable them to obtain an Experimental Use Permit (EUP) to supply diphacinone to Conservancies. This EUP has now expired (S. Boswell pers. comm.) so DOC will need to arrange for a new permit to continue using diphacinone in hen eggs for stoat control.

In a partial replicate of the 1080 trial, but using 1 mg of 1080 per egg, Miller and Elliot (1997) found egg consumption decreased by 100% in 3 weeks in one area of North Okarito Forest. In a replicate of the diphacinone trials, egg consumption by stoats in the Waimakariri Valley decreased from > 20 eggs/day before poison-baiting to 1–2 eggs/day 6 weeks after.

The use of egg consumption to measure the effectiveness of poison-baiting assumes that egg consumption is proportional to the number of stoats present. Ideally, stoat numbers should be monitored independently of the poison-baiting programme, e.g. using radio-telemetry, kill-trapping, or footprint tracking, to avoid problems of bait shyness. Unfortunately, the budget was insufficient to allow the use of radio-transmitters in the present trials. Kill-traps could not have been used in the pre-poison period because they would have reduced stoat numbers in both poison and non-poison areas, and footprint tracking records of stoats are unreliable (King 1994). Bait or poison shyness was not observed among captive stoats, so the average number of eggs per day eaten by stoats was used as an index of stoat numbers in these trials. A concern about using bait consumption for monitoring population numbers is that it

may reflect changes only in the population of animals willing to eat baits (Cowan and Townsend 1994). Further trials using methods other than egg consumption are needed to substantiate the results of this study. To date, attempts at measuring the impacts of poison-baiting on stoat survival using radio-telemetry have experienced problems with high pre-poison mortality of radio-tagged stoats, extensive movement of radio-tagged stoats, and malfunctioning of transmitters (Dilks 1997, King 1997, Miller and Elliot 1997). If these problems cannot be overcome, then future trials should use live-trapping to monitor the effectiveness of poison-baiting for stoat control.

5. Recommendations

5.1 MANAGEMENT RECOMMENDATIONS

The author recommends that conservation managers use:

- Hen eggs as baits for stoat control because they are the best long-life bait identified to date.
- Sodium monofluoroacetate (1080) in hen eggs for stoat control when it is important to reduce stoat numbers immediately.
- Diphacinone in hen eggs when use of 1080 would be problematic, when immediate reduction in stoat numbers is not important, or when it can be circumvented by poisoning earlier in the season.

Instructions for the use of poisoned hen eggs for stoat control are given by Spurr and Hough (1997).

5.2 RESEARCH RECOMMENDATIONS

As a follow-up to this research, the author recommends:

- Trying dead mice and hen eggs together as mixed baits (one highly palatable but with a short-life and the other less palatable but with a longer-life) in replicated toxic field trials using radio-collared stoats in an attempt to maximise the number of stoats (especially females) eating toxic baits.
- Investigating PussOff® cat bait, if available, and natural food odours (e.g. mouse odour) to develop a long-life bait that is attractive and palatable to stoats.
- Evaluating PestOff® ferret paste for its efficacy for stoat control in replicated field trials using radio-collared stoats.
- Evaluating Cholecalciferol (in hen eggs and / or dead mice or fish-paste) for its efficacy for stoat control in replicated field trials using radio-collared stoats.

These research projects are best undertaken as a collaborative effort between the Department of Conservation (field expertise in stoat control) and Landcare Research (expertise in experimental research and in bait and poison development).

6. Acknowledgements

This research was undertaken for the Department of Conservation, Wellington, between 1991/92 and 1997/98 (Investigation No. 1088, Landcare Research Contract LC9899/26). I thank G. Wright, D. Batcheler, and M. Potts for laboratory assistance; S.J. Hough for field assistance; G. Loh and S. Phillipson for collaboration in the research-by-management trials; L. Milne, A. Rhodes, P. Wenmoth-Hann, and N. Young for looking after the captive stoats; R. Barker, J. Brown, C. Frampton, and W. Ruscoe for statistical advice; C. Eason for comments on the draft manuscript; C. Bezar for editorial assistance; T. Pearson for preparing the figures; and W. Weller for word-processing.

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