April 2018

A8

PEST MUSTELIDS

MONITORING AND CONTROL

PRODUCED BY

National Pest Control Agencies

ABOUT NPCA

This document was published by NPCA (National Pest Control Agencies) which, until part way through 2018, provided a co-ordinating forum for agencies and stakeholders to address vertebrate animal pest control in New Zealand. In 2018 its role was largely taken over by the Ministry for Primary Industries.

PUBLICATIONS

Most of NPCA's publications on animal pest control were partially updated in April 2018 and transferred to the library section of the Ministry for Primary Industries' 'BioNet' online portal. The updates reflect the transfer and also acknowledge the change in the regulatory regime during 2017 and 2018, while not fully incorporating these changes in the interim, pending further reviews of the publications. Written by experienced practitioners, the main titles cover:

- best practice guidelines on controlling and monitoring vertebrate pests; and
- information about relevant regulations.

The transferred publications can be found at www.bionet.nz/library

PRODUCED BY National Pest Control Agencies

PEST MUSTELIDS

MONITORING AND CONTROL

Published April 2018

National Pest Control Agencies
c/- info@bionet.nz

ISBN: 978-1-877474-89-7

This guide may be updated from time to time, so please check that your version is current by checking the publications section on **www.bionet.nz/library** or contacting info@bionet.nz.

AMENDMENTS IN THIS EDITION

This April 2018 edition has been updated as part of an interim generic review of most NPCA publications. The purpose is twofold.

» Firstly, to reflect the substantial change in the regulatory regime relating to Health and Safety and use of VTAs (Vertebrate Toxic Agents) in the workplace, which now both sit under the Health and Safety at Work Act 2015, and associated regulations.

» Secondly, to change links to other NPCA publications and contact details now that NPCA's publications have been transferred to the BioNet portal, run by the Ministry for Primary Industries.

The full nature of the regulatory changes have NOT been fully captured here, and users are directed to the source legislation and website information provided by the various administering agencies.

This interim review is intended to be followed up more fully in due course.

CONTENTS

PART 1 INTRODUCTION

1.1 Purpose

These guidelines were commissioned by the National Pest Control Agencies (NPCA).

The practical and regulatory aspects of mustelid control and monitoring are updated and made freely available.

The primary audience is field staff and contractors responsible for undertaking mustelid control and monitoring. The scope of this document is restricted to best practice techniques for control and monitoring of mustelids. Safety considerations are not presented and remain the responsibility of the employer and employee.

The guidelines allow flexibility for ongoing innovation, and tailoring of operational design to local needs.

As regards best practice for mustelid control using toxins, it is intended that the sister publication "*Vertebrate Toxic Agents – Minimum Requirements for the Safe Use and Handling of Vertebrate Toxic Agents*" is read in conjunction with these guidelines. That document is available online at www.bionet.nz/library/ .

1.2 Layout

The document is in four parts:

1. **Introduction.**
2. **Biology and Impact as pest species.** The biology and habits of mustelids are presented and provide a basis for the nature and timing of control and monitoring. Their role in the epidemiology of Tb and effects on native ecosystems are discussed.
3. **Control.** Best practice guidelines are presented for control or exclusion of mustelids.
4. **Monitoring.** Best practice guidelines are presented for design, deployment and reporting of monitoring.

1.3 Acknowledgements

This document collates available published material, much of it included verbatim. We acknowledge the contribution of those authors. The efforts of members of the expert working group are appreciated.

PART 2 BIOLOGY AND IMPACTS OF MUSTELIDS

2.1 Mustelid Biology

Mustelids are a diverse group of small to medium sized carnivores distributed throughout the world. Three species occur in New Zealand, the ferret *Mustela furo,* the stoat *Mustela erminea*, and the weasel *Mustela nivalis*. All have a characteristic long body, short legs and sharp pointed faces. At night all have a strong green eyeshine in the spotlight.

Ferrets are by far the largest, followed by stoats and then the smaller weasel. Ferrets have a creamy yellow woolly undercoat, interspersed with long contour hairs which are black at the tip, giving a general dark appearance. The legs and tail appear darker than the body. The lighter facial region has a dark mask around the eyes and across the nose. Ferrets are primarily nocturnal.

Stoats and weasels are similar looking with brown fur above, and white below, brown face and legs. The easiest way to distinguish stoats and weasels is by the tail. The stoat has a thin brown tail with a distinctive bristly black tip, while the weasel has a thin pointed tail, which is uniformly brown. The males of all species are significantly larger than the female. Field sign of stoats and weasels is difficult to differentiate. Stoats and weasels are active day and night, resting between short periods of intensive hunting.

Ferrets were introduced from the early 1880s, stoats and weasels from the mid 1880s, to control the burgeoning rabbit problem. Whilst they were ineffective in controlling rabbit populations, their own status as pests was quickly recognised and all legal protection was removed around 1900.

Mustelids are widespread in the North and South Islands. Ferrets are uncommon in forest but frequently found in association with rabbits on developed and rough farmland habitats and high country where they are more abundant than stoats. Ferrets rarely occur in areas with more than 1500 mm annual rainfall.

Stoats are the most common forest species and distributed throughout most habitats, being able to tolerate extremes of rainfall and temperature. Stoat populations are naturally unstable and determined mainly by availability of food supply. Their short life spans combined with high and variable birth and death rates make stoats very difficult to manage with anything other than continuous control.

Weasels are rarely seen, very patchy in their distribution, and prefer disturbed[1] habitats.

Whilst stoats and weasels are derived from feral populations, the ferret is a domesticated form of the polecat, and even now is relatively docile when caught.

[1] "Weasels prefer thick ground cover, so they favour overgrown patches of any habitat from suburban gardens to agricultural land, in scrub and cutover native or exotic forest, or at the margins between these and open country." From King C.M. 2005. Handbook of NZ Mammals.

All species are able to swim. The stoat is a particularly willing and able swimmer over distances of up to 1500 metres, having thus established populations on offshore islands. Stoats and weasels are very competent climbers, whilst ferrets tend to stay on the ground.

Stoats are the most opportunistic of these carnivores, taking a wide range of prey; which may explain why they are more widespread than either ferrets or weasels. While ferrets and weasels will also both take a range of prey, ferrets tend to be more reliant on rabbit populations and weasels on mice populations. Weasels are thought to be prone to localised extinction over a season if numbers of mice and other small prey are low.

Carolyn King's book, *Handbook of New Zealand Mammals*, is an authoritative source of further information on mustelids.

Table 1. Mustelid fact comparisons

	Ferrets	**Stoats**	**Weasels**
Average male weight	1200 g	324 g	126 g
Average female weight	600 g	207 g	57 g
Average life span	< 1 year (max 5-10)	< 1 year (max 3-8)	< 1 year (max 2-3)
Breeding season	Usually September to October but can last longer	September to November	September to March
Usual number of litters per year	1 (max 2)	1	1-2 (max 3)
Usual litter size	4-8 (max 12)	8-10 (max 20)	3-6 (max 11)
Juvenile dispersal	February to March	Most often December to January but sometimes can start in November.	January to May
Known dispersal distances	Up to 45 km	Up to 65 km	None published
Average home ranges (min-max)	Males 200 ha (80-760) Females 122 ha (45-230)	Males 147 ha (16-313) Females 79 ha (9-127)	Males 1-192 ha Females from less than 1 to 29 ha (Not averages but min-max from overseas studies)

2.2 Impacts

Ferrets are a significant pest of both conservation and economic importance in New Zealand. Ferrets prey on indigenous wildlife and they also carry bovine tuberculosis (Tb), a disease which may threaten New Zealand's international beef, dairy and venison markets.

There is substantial possum-to-ferret transmission of Tb and controlling possum populations is the logical first step to managing Tb infection in ferret populations, especially at sites with low ferret density. At higher ferret densities there is evidence of ferret to ferret transmission of Tb and TBfree New Zealand considers ferret control an important part of Tb management in such instances.

Ferrets have a significant effect on many riverbed breeding birds e.g. black stilt, dotterel species and pied oystercatcher. Ferrets are known to prey on royal albatross chicks, yellow-eyed penguin and little blue penguin, weka, North Island kiwi (including adults) and numerous freshwater wetland birds. They are considered one of the major causes of decline in white-flippered penguin populations and a significant and probable main cause (along with cats) of massive range contractions of grand and Otago skinks.

When rabbit numbers are lowered with a control programme, ferrets will change their diet to other species, thus increasing the risk to native species temporarily. However, a study in the Mackenzie Basin showed that reducing rabbits largely controls ferret populations, so reducing predation of native fauna in the longer term.

Stoats are considered to be the most numerous and most destructive predator of native birds in New Zealand forests, implicated in the extinction of up to 30 species. Birds that nest in tree holes, such as mohua and yellow-crowned parakeet, are particularly at risk. As the following examples show, there is good evidence that trapping stoats can make a big difference to the survival of native birds.

- Low intensity stoat control was initiated in the Eglinton Valley (13,000 ha) using a single 40-km line of traps spaced 200 m apart with traps set continuously. 25 kaka nests in the control area produced 55 fledglings compared to a 90% fledgling failure where there was no control.
- Stoats are an important predator of kiwi chicks. Without active stoat control, as few as only 5% of chicks each year are likely to survive to a safe weight.
- Stoat trapping at Craigieburn resulted in an 80% survival rate for bellbird chicks and the population size also increased by 80%. Again, where no trapping was carried out, fledgling survival was only 8%.

Weasels, being more patchily distributed and at much lower density, are thought not to pose a significant conservation risk. They may, however, damage small and localised populations of endangered species such as, Whitaker’s skink for example.

PART 3 CONTROL

3.1 Management Options and Timing of Control

Mustelids can be managed by trapping, shooting, poisoning (including secondary poisoning), fumigation, dogging, control of prey species, and exclusion fences. Of these options, shooting is considered inefficient and is not further considered. Similarly, fumigation is not a viable method on its own, though it can be used effectively in conjunction with predator dogs, as mustelids commonly den in rat, possum or rabbit holes.

Control of rabbits may result in a reduction in ferret populations where rabbits are a primary food source. Also, secondary poisoning, following 1080 and brodifacoum poison operations against possums or rabbits, can reduce mustelid populations, particularly where brodifacoum is used. However, possum and rabbit control operations are not usually repeated with sufficient frequency to on their own maintain low mustelid populations.

Weasels are rarely targeted specifically for control, as they present little threat to the survival of any native species. Their populations are naturally unstable and liable to frequent local extinction. While they are captured in traps set for stoats and sometimes ferrets, the trapping grids for those species are unlikely to be spaced closely enough to target all weasels in an area due weasels' smaller home range. A rat trapping grid is probably a more suitable spacing. Control of weasels is not further discussed.

Control needs to be continuous, or at least annual, and over large areas to be effective. The reasons being:

- ferrets and stoats have large home ranges;
- mustelid populations can quickly increase to take advantage of increased food supply because a female produces a relatively large number of young in a season;
- reinvasion is a problem because juvenile mustelids will disperse large distances (up to 45 km) and prefer to settle in areas of lower population density (i.e. the control area).

Exclusion fencing is the alternative to ongoing control and this is becoming more popular in New Zealand, especially for smaller 'mainland island' style conservation projects.

For ferrets, control[2] is best done in autumn, after juveniles have settled in a new location, to minimise reinvasion of an area by more juveniles. Also, both trapping and poisoning are most effective from late summer through autumn, and poisoning remains effective into early winter. Ferrets are difficult to trap during winter and female ferrets are also difficult to trap during the breeding season. This difficulty could be due to the animals avoiding new objects in the environment and may be partly overcome by leaving traps and bait stations in place continuously. However, successfully targeting breeding females remains a problem.

For stoats, control generally needs to be right through the year, depending on the resource being protected. For example, to protect kiwi chicks, ferrets and stoats need to be controlled all year because adults, chicks and eggs are vulnerable. To protect yellow-eyed penguins,

[2] A more detailed document detailing options for ferret management has been prepared for TBfree New Zealand, and is recommended reading. (Ragg, J. R, Clapperton, B. K. 2004 Ferret Control Manual. Animal Health Board Project Project R-80596.)

ferrets need to be controlled for more than six months of the year, from laying in September through to March, when the chicks fledge. To protect kaka, stoats need to be controlled while the females are on the nest until the chicks fledge.

3.2 Trapping

Trapping is an effective tool for mustelid control, particularly where a permanent trapping grid is maintained. Because live traps require daily checking, kill traps are recommended, although no.1 leg-hold traps are often used for one-off ferret control operations over large areas. Kill traps should be placed in tunnels to minimise non-target captures.

The NPCA does not sanction the use of traps which have not passed testing under the National Animal Welfare Advisory Committee (NAWAC) guidelines for humaneness[3], At the time of writing, the only kill traps to have passed testing under the NAWAC guidelines are the hammer trap (NZTrap), the DOC 150 and 200 (for stoats and weasels) and the DOC 250 (for all mustelid species). The Hammer trap is less commonly used, perhaps because of its higher cost.

Traps such as the Fenn series and the Timms trap (for ferrets) have been, and continue to be, legally used despite having been shown not to meet the standards for humane traps.

Doc 250 Set

Doc 250 Sprung

Tunnels should:

[3] NPCA does not endorse any individual trap type. Any trap types which have failed NAWAC testing are not recommended for use against that target species.

- be made of solid material so traps and bait are out of the weather, and kiwi or weka can't poke their bills through;
- be at least 600 mm long, or where weka are present 950 mm long to prevent them accessing the traps, and have a solid base to prevent birds digging under the cover;
- have a tunnel width that matches the trap being used;
- have double baffles at entry ends;
- have entry holes that restrict non-target animals while allowing the target species to enter (75 mm diameter for ferrets, 50 mm diameter for stoats);
- be 'see through' at either end;
- be of solid anchorable design to prevent traps being disturbed by pigs and possums;
- have a removable roof for ease of operator access.

Experience dictates a range of best practice considerations for the field trapping of mustelids.

- Traps should be regularly maintained, including checking for worn pivots and weakened springs.
- Permanent trap sites are most effective (10 days absolute minimum).
- When targeting ferrets, if a trap has not caught for some time, move it to another likely location nearby. Often, moving a trap only a small distance will see it start to catch.
- Replace bait when it spoils and dispose of old bait away from the trap-site.
- Swap bait types from time to time.
- When a mustelid is caught, rub the anal scent gland around trap entrance and inside cover.
- Disturbance/scuffing of fresh earth in front of/around a trap can increase interest from mustelids.
- Intensify trap line spacing around trapping 'hot spots' i.e. drop spacing down to 50 m around good habitat or high catch areas.
- Each trap station should be numbered for ease of relocation and data collection, so individual trap sites can be assessed for catch history.

An excellent source of information relating to mustelid trapping in New Zealand can be found at http://www.predatortraps.com/

Stoat trap lines should follow habitat perimeters, ridges, tracks, altitudinal contours, waterways and best practicable access.

Ferret trapping in more open country is targeted to suitable sites, also along fairly informal lines.

Ferrets tend to concentrate where there is a good source of food or shelter and along access ways such as sheep tracks. Good trap sites include:

- dry country (sunny warm faces) with rabbits;
- hay barns with mice;
- offal pits with rats;
- dams and creeks with frogs and eels;
- alongside country roads where ferrets make an easy living from animals run over on the road;
- along edges of creeks (very effective);
- beside tracks or drain pipes under tracks;
- clear areas under trees;
- in rabbit holes;
- possum dens;
- lone trees;
- gateposts (especially those marked by dogs);
- on approaches to bridges/culverts;
- along the bases of banks;
- edges of vegetation.

Table 2. Mustelid trapping guide

	Ferrets	**Stoats**
Trap Types	DOC 250, Timm, KBL tunnel	DOC 200 or 150 (250 if also targeting ferrets)
Baits	Mice, fresh meat (e.g. rabbit, hare, beef less preferred), long-life polymer bait, eggs (particularly if also targeting stoats).	White uncracked hen eggs, fresh, salted or dried rabbit meat. Replace bait when it spoils, hen eggs and salted or dried rabbit meat last longer than fresh meat. A combination of egg and meat can be effective.
Lures	Drag dead rabbit up to and about the trap site	None
Trap spacing	200 – 400 m	100-200 m
Trap line spacing	1000 m	800-1000 m
Trap checking	Weekly between January and May, monthly between June and December.	12 times per year minimum

3.3 Poisoning

Stoats may be poisoned with PAPP (Para-aminopropriophenone). This product is required to be under the control of, or secured by, a certified handler who also holds a controlled substances license. For more information refer www.worksafe.govt.nz

Diphacinone poison is registered for ferret control, marketed as "**Pestoff Ferret Paste**", a blended fish paste containing 0.3g/kg of diphacinone anti-coagulant poison. Apply as single 100 g (approx.) paste baits in Pestoff Tunnel Bait Stations. Available in 450 g tubes from Animal Control Products www.pestoff.co.nz

Alternative tunnels may be used as long as they effectively exclude non-target species. Siting of bait stations and spacing of bait station lines is the same as for trapping (refer 3.2 Trapping).

Ferrets take poison baits most readily from summer through to early winter.

Check and replace baits weekly, until baits stop being taken. Expect re-invasion to occur quickly and be prepared to undertake poisoning regularly.

Alternating the use of traps and poison is recommended for ongoing control programs. Poison can be readily applied inside established trap tunnels.
The sister publication *Vertebrate Toxic Agents – Minimum Requirements for the Safe Use and Handling of Vertebrate Toxic Agents* is to be read in conjunction with these guidelines. That document is available online at www.bionet.nz/library/ .

3.4 Dogs

Predator control using dogs is effective and an important tool where very low or zero densities of mustelids is required (e.g. offshore or mainland islands).

Training and operating predator dogs is highly specialised and beyond the scope of this document.

The Department of Conservation's Research, Development and Improvement Division co-ordinates a national predator dog programme. The Department has operated predator dog teams for some years and may become involved with projects throughout New Zealand, depending on the perceived conservation benefits.

Contact Scott Theobald, Ranger, Department of Conservation, Research, Development & Improvement Division, Wellington.

The TBfree New Zealand is considering the establishment of a specialised predator dog team for ferret control.

3.5 Fencing

Effective pest-proof fencing is a new conservation management tool. It offers a permanent solution for the protection of wildlife, and the enhancement of native forest areas, bush remnants or wetlands. Fencing offers the potential to eradicate pests from protected areas.

Fencing technology has taken off in recent times, and a substantial project on Maungatautari is now underway which would have been inconceivable 10 years ago. See http://www.maungatrust.org/

Because of the small size of stoats and weasels, and their climbing ability, exclusion fencing is a specialised task. A suggested supplier operating in New Zealand since 1998 is the Xcluder company (see http://www.xcluder.co.nz/)

PART 4 MONITORING

4.1 Monitoring Techniques

Monitoring mustelid populations directly is difficult. Mustelid populations are inherently subject to substantial seasonal and between-year fluctuations. Trap catch indices are unreliable because trapping is often a mainstay of control, and mustelid behaviour makes their trappability variable and unreliable.

A best-practice protocol for trap-catch monitoring of ferret populations has been developed and is available online at www.bionet.nz/library/ . Because ferret trappability is variable, the protocol is useful only for measuring population trends and cannot be used to accurately measure the effect of control operations on ferret populations in the way that similar protocols work for possums for instance. This methodology is rarely if ever used in New Zealand and is effectively obsolete.

Tracking tunnels are used to monitor mustelid populations, particularly stoats and weasels, though they only provide a coarse index of relative abundance. They are not a direct measure of population density but a measure of activity. The technique is best suited for providing simultaneous comparisons of the relative abundance of mustelids between similar habitat areas (e.g. treatment and non-treatment) or changes in relative abundance over time at a single site. The technique is suited to low-medium population densities, as device saturation occurs at higher densities. As tracking tunnels are not always sensitive to mustelid activity, be aware that detecting nothing should be interpreted as a low, but not necessarily zero, population density.

Arguably, the most appropriate approach to measuring the success of mustelid control for conservation is outcome monitoring. For example, measuring fledgling success of a bird species being protected, or some other relevant ecological measure.

4.2 Tracking Tunnels

In the interest of maintaining national consistency of this monitoring technique, elements of the Department of Conservation tracking protocol, prepared by Craig Gillies and Dale Williams are presented below, as applicable to mustelids. Some background information has been removed.

1.4.2 Introduction

Using tracking tunnels as a method for monitoring small mammal abundance in New Zealand was first described by King and Edgar (1977). The technique uses a 'run through' tunnel containing two pieces of paper either side of a sponge soaked with a tracking medium (food colouring). As an animal passes through the tunnel it picks up the tracking medium on its feet, then, as it departs from the tunnel, it leaves a set of footprints on the papers. It is a non-destructive sampling technique so it does not impact the target population or, for that matter, any non-target species.

The minimum number of mustelid tracking surveys for ongoing studies should ideally be at least once per season but you should be aware that the summer peak in stoat abundance usually lasts only for a very brief time and this is when many species of native birds appear to be most vulnerable to these predators. The desired management outcomes at your site should determine when you conduct these mustelid surveys but you may need to consider conducting several mustelid surveys over spring and summer (November, December, January and February are the best months for stoats).

2.4.2 Methods

For most study sites (300 to 10,000 ha), four to fifteen lines should be sufficient for surveying mustelids.

Table 3. Mustelid tracking tunnel densities

Approximate area to be surveyed	*≤300 ha*	*300-600 ha*	*600-900 ha*	*900-1,200 ha*	*1,200-10,000 ha*	*>10,000 ha*
Suggested number of tracking tunnel lines for mustelids	4-5	6-7	7-8	9-10	10-15 lines	15 (or more if logistically feasible)

Each tunnel line consists of 5 tunnels set at 100 m spacings. Any lines you intend to use to monitor mustelids should be a minimum of 1000 m from the nearest adjacent mustelid line at the closest point.

When setting out tracking tunnel lines, it is important to ensure that representative environments are sampled via stratification. Consider the environment types that make up your management area and what proportion of that area they make up. So, for example, if 50% of your study area is red beech forest, then 50% of your sampling effort should include that environment.

Generally speaking, the start points for each line should be determined by environment type, access, logistics (all lines need to be serviced on the same day) and the distance away from the next nearest tunnel line. This design methodology therefore differs from other NPCA monitoring protocols, in that line selection is neither random nor systematic. Should you wish to incorporate a randomised or systematic sampling design, consult the Possum Monitoring Trap-Catch or Waxtag Protocols, available online at www.bionet.nz/library/ .

When determining the direction of a tunnel line, avoid biasing the sample by running lines entirely along geographic features (e.g. roads, ridgelines or streams) or other potential sources of bias such as along bait station lines. The best way to avoid any bias is to randomise the direction each tunnel line runs. A simple method we use is to roll a six-sided die and the number rolled determines the compass bearing from the start point along which the line is set out (). Run the line in the most practicable of the two bearings either Easterly or Westerly from the designated start point, if you can't decide which to choose, roll the dice again. If the result is an odd number pick the Westerly bearing and the Easterly if the die result is even.

Table 4. Randomising tracking tunnel lines

Die roll	*Angle of tunnel line (magnetic)*
1	285°W-105°E
2	315°W-135°E
3	345°W-165°E
4	15°E-195°W
5	45°E-225°W
6	75°E-255°W

3.4.2 Setting the lines

1. Set out the tunnels at least three weeks prior to the first survey session to ensure any resident animals are conditioned to the presence of the tunnels.
2. Leave the tunnels in place between survey sessions.
3. Mark the tunnel locations with flagging tape or permanent plastic triangle track markers. Since the tunnels are left in situ between surveys (in some cases several years) the locations of the tunnels need to be well marked. When using flagging-tape to mark tracks it is a good idea to use one colour to mark the track and another to mark the tunnel.
4. Write each tunnel number on the flagging-tape or plastic triangle at the tunnel site with a permanent indelible ink marker pen.
5. Assemble the tunnels as you put them out in the field. It is a lot easier to carry the bases, trays and pre-cut corflute for 10 tunnels than it is to carry 10 fully assembled tunnels.
6. Site the tunnel at the most suitable spot within two metres of the 50 m marker along the line (e.g. places that look like they would provide a good ‘run’ for mustelids).
7. Place each tunnel on reasonably level ground as this will reduce the chances of the food-colouring running from the middle sponge tray and blotting out the paper on the down hill side.
8. Ensure that the tunnel is firmly in place by pegging the tunnel down with two No.8 wire loops.
9. Check that access to both ends of the tunnel is unobstructed.

4.4.2 Tunnel construction

Each tunnel consists of a wooden base with a black plastic ‘coreflute’ cover. Coreflute is the material used for real estate signs. In the majority of cases these tunnels are quite resistant to interference and damage by other animals, however, if kea, weka or possum interference is so bad that it is compromising the amount of data you are collecting from your surveys then we suggest you consider using the ‘Te Anau Area Office tunnel design’ overleaf. The tracking papers and sponge are placed in a separate tray that sits inside the tunnel on the wooden base. Jurgen Fiedler Plastics in Rotorua manufacture polycarbonate trays specifically for this purpose, which should last for five to ten years. Use red (Amaranth 123) food colouring as the tracking media on the sponge. Alternatively, Connovation in Auckland supply prefabricated tunnels and pre-inked cards for those people who would prefer not to construct their own tunnels or use the food colouring and paper tracking media.

The "Te Anau Area Office tunnel design", courtesy of Megan Williams

- Tunnel cover, one sheet of black polypropylene plastic - 350mm (W) x 900mm (L) x 1.5mm thick.
- Wooden base, H4 treated rough sawn timber - 100mm(W) x 535mm (L) x 25mm thick
- Nails: 30mm Anualer S/S lumberlock flatheads - 10 nails for each tunnel.
- No 8 wire brackets (fashioned to shape at local engineering shop). The wire not only helps prevent possums, kea and weka from reaching in, but also keeps the plastic tray from sliding out. The wire may not be suitable for a lot of areas where you want larger animals using the tunnels.

Suggested suppliers for tunnel materials

- **Polycarbonate trays**. Jurgen Fielder Plastics (P.O. Box 6071 Rotorua). ph (07) 343 5542 or Fax (07) 348-0952.
- **Black corflute sheets.** Mico Wakefield (Mico Pipelines Division), www.mico.co.nz, contact nearest branch. Sometimes they will also cut these to size if you can afford the additional cost.
- **Sponges.** Para Rubber, www.pararubber.co.nz, contact nearest branch. A 1350mm x 1500mm sheet should make around 180 pads.
- **Food colouring.** Hansells (NZ) Ltd., www.hansells.co.nz, Opaki Rd, Private Bag 410 Masterton, (ph: 0800-733-663, Fax: 06-377-3114, e-mail orders@hansells.co.nz) will bulk supply food colouring. Please specify that you require the red colour code Amaranth 123.
- **Papers.** EC Attwoods Ltd., www.attwoods.co.nz, Head Office, PO Box 37-568, Parnell, (ph 0800 722548, Fax 0800 377758). This company will supply pre-cut papers for tracking tunnels. Other printing firms will often supply pre-cut papers at relatively low cost too.
- **Prefabricated tunnels and pre-inked cards**. Connovation, PO Box 58613 Greenmount, Auckland (ph 09 273 4333, Fax 09 273 4334 E-mail info@connovation.co.nz). They can supply pre-inked cards separately if required

Tunnel dimensions and materials

- Wooden base, 100mm (W) x 535mm (L) plywood or 25 mm thick rough sawn pine.
- Tunnel cover, black corflute, stapled or nailed to the base, 615 mm (L) allows for 40 mm overhang each end of timber, tunnel internal clearance height should be 100 mm.
- Polycarbonate trays, 520 mm (L) x 95 mm (W), with each of the three partitions being 173 mm (L).
- Papers, each paper should be pre-cut to 173 mm x 95 mm in size. We strongly suggest you source this pre-cut from a printer, as hand cutting can be very time consuming. The type of paper may be determined by local availability (and cost) but ensure it is sufficiently absorbent to retain the food colouring animal prints. Sponge, 173 mm x 95 mm in size and 3-5 mm thick. Sponge, 173 mm x 95 mm in size and 3-5 mm thick.
- Tracking media, use liquid red (Amaranth 123) food colouring at approximately 1:3 dilution in water. In extremely dry conditions or where you think freezing is likely to be an issue, mix the food colouring and water solution with polyethelene glycol (approximately 20%).

5.4.2 Using the tracking tunnels to monitor mustelids

Mustelid surveys should be conducted over three consecutive fine nights (or at least three nights where you can reasonably expect a period of weather with no heavy rainfall).

Day One

1. Place fresh papers in each tunnel. Remove any scats from the tray and tunnel.
2. Check that the sponge is in good condition, fits neatly into the tray, and contains adequate food colouring. An old “H_2Go” or similar type of plastic water bottle is an easy (and less messy) way of applying food colouring to the sponges in the field. You will need to carry spare sponges and scissors to ensure replacement sponge fit the trays.
3. Bait the tunnels with a generous 4 - 6 cm^3 sized chunk of skinned rabbit meat placed in the center of the sponge (on a 4 cm x 4 cm square of polythene or suitably sized leaf to keep maggots off the sponge). Ensure any uneaten peanut butter left over from any rodent surveys is flicked off the base.

After 3 nights

1. Keep the papers in order as you collect them, write the tunnel number on each paper, on the end closest to the tunnel entrance. Writing the numbers on the outside edge of the paper will help you to sort the papers after the survey (it is often easier to identify footprints if the papers are arranged in the same direction as most of the tracks will be heading from the inside outwards). Keeping the papers in order will help you to identify any mistakes (i.e. if you miss a tunnel or make an error with the numbering).
2. Check the papers in the field (if you have mastered the identification process) and keep a running total of the results in a notebook. This may help to eliminate mistakes and problems with identifying faint tracks.
3. Make a note of any fresh scats found in a tunnel, and count that particular species being present, even if there are no tracks recorded.
4. Note anything of interest or importance (e.g. possum disturbance, particularly if the papers and or trays have been pulled out these tunnels need to be accounted for when analysing the data).
5. Record when the bait is taken from untracked tunnels.
6. Remove the bait.

Once you are back in the office

1. Spread the papers out to dry (if needed) and double check your results.
2. Label the bundles of tracking papers with the survey area and the date, and store for later reference.

If the tracks appear extremely faint, check to see if they have not been transferred from another paper. This is most likely to happen if the papers were wet when they were collected. When we were trialing this technique we found that placing each paper separately between the pages of an old paperback novel whilst we were collecting them stopped this from happening, plus it helped absorb any excess moisture from the papers. If you see faint tracks when collecting the papers and are concerned that they may be overlooked later, note the species and highlight the tracks by circling them in pencil, while in the field. This is also a good reason for handling the papers carefully when you are collecting them and keeping a running total of the results in a notebook as you check each tunnel. Partial tracks or footprints can often occur if the sponge has dried out, the food colouring was too dilute, or if the animal has backed out after placing only one foot on the sponge. If a set of prints is too obscure to identify, mark it down as unidentified.

6.4.2 Identifying small mammal tracks and scats

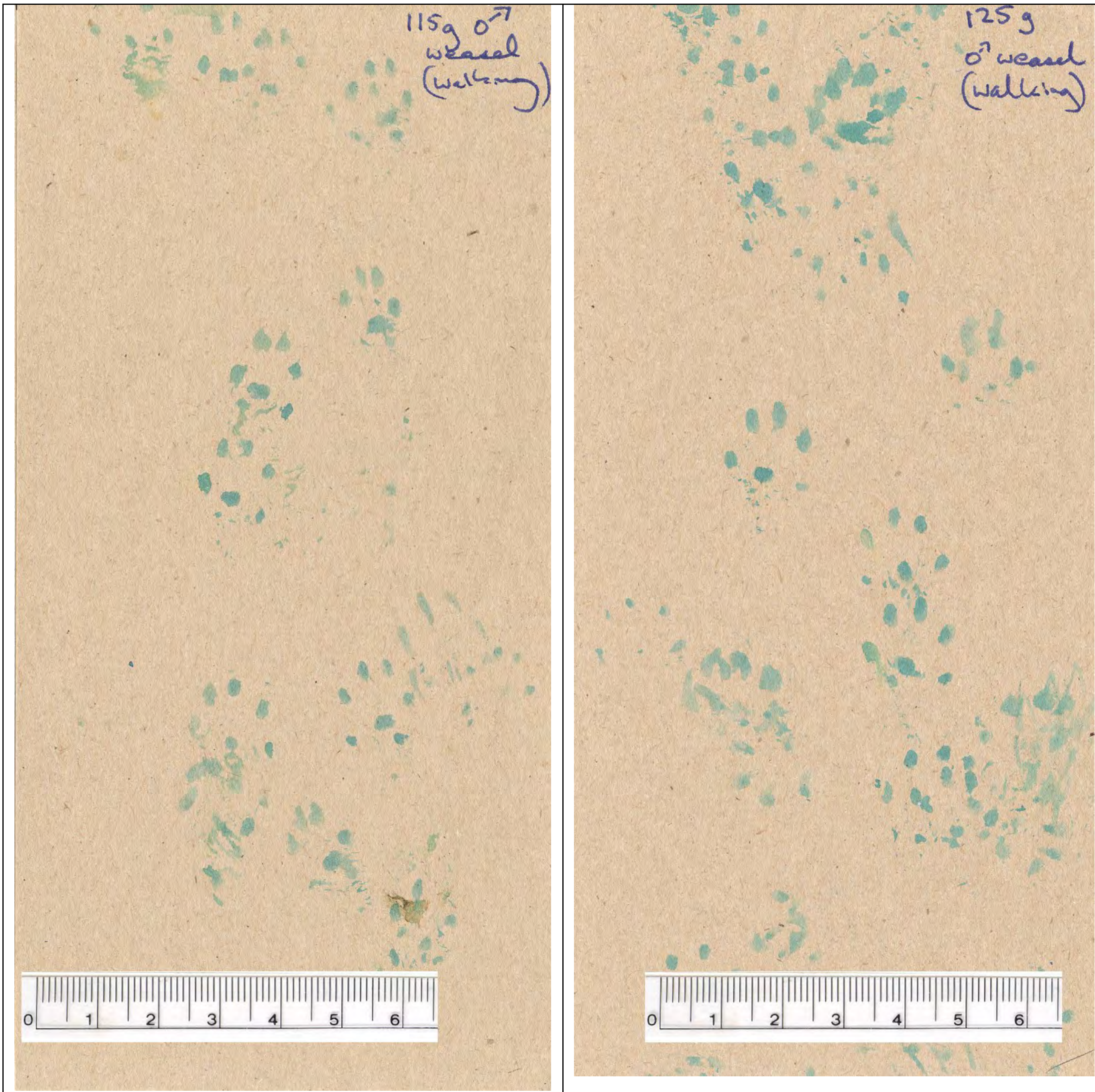
This can often be one of the more difficult aspects of the technique. However, after some practice it becomes relatively easy to quickly identify the tracks of different small mammals at a glance.

Stoat footprints measure approx 20 mm long and 22 mm wide (front) and 42 mm by 25 mm (rear feet), though full foot prints only show in softer ground. Only the semi-circle arrangement of 5 pads often show on harder surfaces e,g. tracking tunnels. Weasel footprints cannot be distinguished from juvenile stoats.

Scats are black, long and thin, and usually are full of bones, feathers or fur. Scat length 40-80 mm. Scats are often deposited as a 'marker' in prominent positions such as on top of logs or stones along travelling routes. Scats of stoats can be confused with those of ferret and weasel (variable only in relative size) and can at times be confused visually with blackish bird droppings but constituents of droppings should identify the owner.

Stoat prints on tracking paper

All photos courtesy of Dr Craig Gillies, DOC.



Weasel prints on tracking paper

Ferret prints are similar to, but larger than stoats. Scats similar to stoats and weasels but much larger, usually 70 mm long and 10 mm wide. Black colour with twisted tapering ends, usually full of fur, feathers and bone fragments.

Ferret prints on tracking paper

We strongly recommend you read the paper – ‘Identification of footprints of some small mammals’. *Mammalia* 61: 431-441. 946 Ratz, H. 1997.

7.4.2 Calculating the tracking index

The tracking index is expressed as the mean percentage of tunnels tracked per line. The information you record is the presence or absence of a particular species in a tunnel, so it is not important how many tracks are on each paper or if only one paper is tracked or if only scats were recorded.

1. Total the number of tunnels on each line that have tracks present (or fresh scats that indicate the animal had been present). Do this separately for each species.
2. Total the number of tunnels on each line that were badly disturbed (e.g. by possums) and whose papers show no tracks, then multiply this number by 0.5. Subtract this number from the total number of available tunnels on each line (5). We define a tunnel as being badly disturbed when both papers are removed from the tunnel and it is obvious that the target animals would not have been able to leave tracks on the papers.
3. Divide the number of tunnels tracked on each line by the number of available tunnels in each line and multiply this figure by 100. This gives the percent-tracking rate (for each line). Do this separately for each species.
4. Calculate the mean (average) percent-tracking rate over all the lines. To do this add the percent tracking rates from each line and divide the total by the number of lines. Do this separately for each species.
5. Calculate the standard error of the mean. The standard error (SE) is simply a measure of the precision of the mean. It is often very useful to express the mean percent tracking rate plus or minus SE (e.g. the mean rat-tracking rate was 35% ± 6%). The standard error can be calculated from the standard deviation. The standard error is equal to the standard deviation divided by the square root of the sample size, which for these surveys is the square root of the number of lines. Do this separately for each species.

Appendix 1 – Guidelines for ferret survey (Tb) sampling

The following guidelines for ferret Tb survey sampling were provided by Environment Waikato, presented verbatim. These are relevant for TBfree New Zealand survey purposes, subject to contract requirements.

Best Practice Guidelines for Ferret Control

Ferrets have been proven to be vectors of Tb disease and ferret control is an important part of the Waikato Tb programme. For those ferret control operations that specify samples to be collected and stored so they can be autopsied and cultured to determine their Tb status, the following control techniques apply. For all other ferret control operations (i.e. those that do not require samples to be collected), please refer to the TBfree *New Zealand Ferret Control Manual* (Ragg & Clapperton, 2004), available on the TBfree New Zealand website.

Trapping

Trapping of feral ferrets is to be undertaken in accordance with the following best practice techniques.

1. Prepare operational plan detailing manner in which ferret control will be undertaken.
2. Use only Fenn No. 6; Victor No. 1; Timms traps or Holden type live capture traps.

3. Ensure fresh meat bait or polymer lured baits are used.
4. Maintain trap sets for a 10-day period.
5. Place traps in areas likely to attract ferrets.
6. Density of traps should be five per 100 hectares minimum where potential ferret habitat exists.
7. All trap sites are to be GPS recorded and logged onto appropriate maps.
8. Traps to be checked within eight hours of sunrise on each day that the traps remain set.
9. For carcass storage in the field, please refer to *TBfree New Zealand Ferret Control Manual* (Ragg & Clapperton, 2004), Section 4.4 ‘Presenting Ferrets for Autopsy’.
10. Ferret carcasses to be placed on ice and chilled before dispatch to laboratory; or placed in freezer to accumulate sample size to 10 ferrets.
11. Each ferret is to be tagged and identified by trap location, date caught and unique individual number.
12. Where samples are being submitted for autopsy, the samples will be accompanied with the attached TBfree New Zealand sample form.

In any situation where a control contractor identifies a variation in the above process or techniques that provides additional benefit, they shall obtain the agreement of the Vector Manager that the changes will be accepted as an alternative best practice standard.

Ferret Control Samples

(To be used whenever ferrets are being collected as part of a larger vector control contract)

1. Contractors shall capture feral animals in accordance with the Best Practice Guidelines for the Trapping of Ferrets.
2. Contractors shall identify each animal and record information on the Tb Field Data Sheet. A copy of this form has been attached as an example.
3. Contractors shall maintain all animals caught in a chilled or frozen state to maintain the condition of the carcass for autopsy.
4. Once the contractor has obtained 10 sample animals, relating to the same operational area, they shall be packaged together for delivery to the nominated laboratory
5. Contractors shall deliver the chilled or frozen samples to the nominated laboratory, together with a copy of the Tb Field Data Sheet.
6. Contractors shall also forward a copy of each Tb Field Data Sheet (Form 10) with their Post-Operational Report to the Vector Manager.

Survey Samples

(To be used whenever ferrets are being collected as a stand-alone survey.)

1. Contractors shall capture feral animals in accordance with the Best Practice Guidelines for the Trapping of Ferrets.

2. Contractors shall identify each animal and record information on the Tb Field Data Sheet. A copy of this form has been attached as an example.
3. Contractors shall maintain all animals caught in a chilled or frozen state to maintain the condition of the carcass for autopsy.
4. Contractors shall deliver chilled or frozen samples to the nominated laboratory, together with a copy of the Tb Field Data Sheet.
5. Contractors shall also forward a copy of each Tb Field Data Sheet with their post-survey report to the Vector Manager.

BIBLIOGRAPHY[4]

Alterio, N. 1996: Secondary poisoning of stoats (*Mustela erminea*), feral ferrets (*Mustela furo*), and feral house cats (*Felis catus*) by the anticoagulant poison, brodifacoum. *New Zealand Journal of Zoology* 23: 331-338.

Barlow, N. D.; Norbury, G. L. 2001: A simple model for ferret population dynamics and control in semi-arid New Zealand habitats. *Wildlife Research* 28: 87-94.[Abstract]

Boyd, P. 1996. Vector trapping techniques employed at Haldon. In: Ferrets as vectors of tuberculosis and threats to conservation. *Royal Society of New Zealand Miscellaneous Series* 36: 71-72.

Brown, K.; Alterio, N. 1996: Secondary poisoning of ferrets (*Mustela furo*) and poisoning of other mammalian pests by the anticoagulant poison brodifacoum. In: Ferrets as vectors of tuberculosis and threats to conservation. *Royal Society of New Zealand Miscellaneous Series* 36: 34-37.

Byrom, A. E. 2001: Ferrets as vectors of bovine Tb in New Zealand: A review. *Proceedings of the New Zealand Society of Animal Production* 61: 60-63.

Byrom, A. E. 2002: Dispersal and survival of juvenile feral ferrets *Mustela furo* in New Zealand. *Journal of Applied Ecology* 39: 67-78. [popular article on p.1 (1.27MB PDF file)][Abstract]

Byrom, A. E. and E. B. Spurr. 2000: Capturing odours of natural prey as lures for stoat control. Landcare Research Contract Report LC9900/131.[Popular article]

Byrom, A. E., Spurr, E. B., O'Connor, C. E., 2002: Ferret neophobia to traps. Landcare Research Contract Report LC0102/082 (unpublished) 16 pp.

Byrom, A. E., Spurr, E. B., O'Connor, C. E., 2003: Trap catch of ferrets using live and dead prey as lures. Landcare Research Contract Report LC0203 (unpublished).

C.M. King, C.F.J. O'Donnell & S.M. Phillipson (1994). Monitoring and control of mustelids on conservation lands. Part 2: Field and workshop guide. DOC technical series No. 4: DOC, Wellington NZ.

Caley, P. 1996: The efficacy of trapping for reducing ferret abundance. In: Ferrets as vectors of tuberculosis and threats to conservation. *Royal Society of New Zealand Miscellaneous Series* 36: 73.

Caley, P. 1998: Broad-scale possum and ferret correlates of macroscopic Mycobacterium bovis infection in feral ferret populations. *New Zealand Veterinary Journal* 46: 157-162.

Caley, P. Hone. J. 2002: Estimating the force of infection; *Mycobacterium bovis* infection in feral ferrets *Mustela furo* in New Zealand. *Journal of Animal Ecology* 71: 44-54.

Caley, P., Hone, J. Cowan, P. E. 2001: The relationship between prevalence of *Mycobacterium bovis* infection in feral ferrets and possum abundance. New Zealand Veterinary Journal 49:195-200.

[4] Primarily from Science for Conservation 116.

Caley, P., L. M. McElrea, Hone, J. 2002: Mortality rates of feral ferrets (*Mustela furo*) in New Zealand. *Wildlife Research* 29: 323-328.

Caley, P.; Morley, C.; Thomas, M. 1998: Effects of ferret control on cattle reactor incidence, ferret Tb prevalence, and rabbit numbers - the North Canterbury ferret control trials. Landcare Research Contract Report LC9899/044, (Unpublished).

Caley, P.; Morriss, G. 2001: Summer/autumn movements and mortality rates of feral ferrets (*Mustela furo*) at a farmland site in North Canterbury, New Zealand. *New Zealand Journal of Ecology* 25: 53-60.

Caley, P.2000: The role of ferrets as hosts of *Mycobacterium bovis*. *In*: Proceedings of the Epidemiology and Animal Health Management Branch Seminar, 23 & 24 November 2000, Wallaceville Animal Research Centre, Upper Hutt *Publication / Foundation for Continuing Education of the NZ Veterinary Association 205.* Palmerston North, Veterinary Continuing Education, Massey University. Pp. 79-86.

Clapperton, B. K. 1996. Scent lures for trapping ferrets (*Mustela furo L.*). In: Ferrets as vectors of tuberculosis and threats to conservation. Royal Society of New Zealand Miscellaneous Series 36: 74-77.

Clapperton, B. K. 2001: Advances in New Zealand mammology 1990-2000: Feral Ferret. *Journal of the Royal Society of New Zealand* 31(1): 185-203.

Clapperton, B.K.; Byrom, A.E. 2005: Ferret. *In*: King, C. M. *ed.* The Handbook of New Zealand Mammals. 2nd edn. Oxford University Press, Melbourne, Australia. Pp. 294-307.

Cunningham, D.M. & Moors, P.J. (1996). Guide to the identification and collection of New Zealand rodents. (3rd edn). Wellington: Department of Conservation.

Fitzgerald, G.; Fitzgerald, N.; Wilkinson, R. 2002: Social acceptability of stoats and stoat control methods: Focus group findings. *Science for Conservation* 207. Department of Conservation, Wellington, New Zealand. [Abstract]

Gouldsbury, P.A. (1967) Predatory Mammals in Britain (a code of practice for their management). Council for Nature Zoological gardens, Regents Park, London.

H. Ratz (1997). Identification of footprints of some small mammals. *Mammalia* **61:** No' 3. 431-441

Hammond, B. 1996. Experience on Mandamus Downs. In: Ferrets as vectors of tuberculosis and threats to conservation. *Royal Society of New Zealand Miscellaneous Series* 36: 69-70.

Heyward, R.P.; Norbury, G. L. 1999: Secondary poisoning of ferrets and cats after 1080 rabbit poisoning. *Wildlife Research* 26: 75-80. [Abstract]

J.A. Brown & C.J. Miller (1998). Monitoring stoat (*Mustela erminea*) control operations: power analysis and design. Science for Conservation: 96. DOC, Wellington NZ.

King, C.M. 2005: Weasel. *In*: King, C. M. *ed.* The Handbook of New Zealand Mammals. 2nd edn. Oxford University Press, Melbourne, Australia. Pp. 287-294.

King C. M.; Moody J. E.; 1982: The biology of the stoat (*Mustela erminea*) in the national parks of New Zealand. *NZ Journal of Zoology* 9: 49-144.

King, C. M.; Flux, M.; Innes, J. G.; Fitzgerald, B. M. 1996: Population biology of small mammals in Pureora Forest Park: 1. Carnivores (*Mustela erminea, M. furo, M. nivalis,* and *Felis catus*). *New Zealand Journal of Ecology* 20: 241-251.

King, C.M.; Murphy, E.C. 2005: Stoat. *In*: King, C. M. *ed.* The Handbook of New Zealand Mammals. 2nd edn. Oxford University Press, Melbourne, Australia. Pp. 261-287.

King, C. M.; Innes, J. G.; Flux, M.; Kimberley, M. O.; Leathwick, J. R.; Williams, D. S. 1996: Distribution and abundance of small mammals in relation to habitat in Pureora Forest Park. *New Zealand Journal of Ecology* 20: 215-240.

King, C.M. & Edgar, R.L. (1977). Techniques for trapping and tracking stoats (*Mustela erminea*); a review, and a new system. *N.Z. J. Zool*. **4:** 193-212.

Laas, F.Y.; Forss, D.A.; Godfrey, M.E.R. 1985. Retention of brodifacoum in sheep and excretion in faeces. *New Zealand Journal of Agricultural Research* 28: 357-359.

Lavers, R. B. 1973. Aspects of the ecology of the ferret, *Mustela putorius forma furo L.*, at Pukepuke Lagoon. *Proceedings of the New Zealand Ecological Society* 20: 7-12.

Lawrence, M.J. & Brown, R.W. (1973) Mammals of Britain: their tracks, trails and sign. Blandford Press, London.

Livingstone, P.G. 1996: Overview of the ferret problem. In: Ferrets as vectors of tuberculosis and threats to conservation: Proceedings of a workshop organised by the Possum and Bovine Tuberculosis Control National Science Strategy Committee 27-28 March 1996. *The Royal Society of New Zealand Miscellaneous Series* 36: 2-6.

Medina-Vogel, G. 1998: Intrasexual territoriality and the spatial and social behaviour of captive feral ferrets (*Mustela furo* L., Carnivora: Mustelidae). Unpublished PhD thesis, Lincoln University, New Zealand.

Medina-Vogel, G.; Hickling, G. J.; Clapperton, B. K. 2000: Assessing spatial activity in captive feral ferrets, *Mustela furo* L., (Carnivora: Mustelidae). *New Zealand Journal of Zoology* 27: 75-83.

Moller, H.; Norbury, G.; King, C. M. 1996. Ecological and behavioural constraints to effective control of ferrets (*Mustela furo*). In: Ferrets as vectors of tuberculosis and threats to conservation. *Royal Society of New Zealand Miscellaneous Series* 36: 54-68.

Moller, H.; Norbury, G.; King, C.M. 1996: Ecological and behavioural constraints to effective control of ferrets (*Mustela furo*). In: Ferrets as vectors of tuberculosis and threats to conservation. *Royal Society of New Zealand Miscellaneous Series* 36: 54-68.

Moors P. J.; Lavers R. B. 1981: Movements and home range of ferrets (*Mustela furo*) at Pukepuke Lagoon, New Zealand. *New Zealand Journal of Zoology* 8: 413423.

Morley, C. G. 1999: The ecology and behaviour of feral ferrets (*Mustela furo*) in Canterbury farmland, New Zealand. Unpublished PhD thesis, University of Canterbury, Christchurch, New Zealand.

Morley, C. G. 1999: The ecology and behaviour of feral ferrets (*Mustela furo*) in Canterbury farmland, New Zealand. Unpublished PhD thesis, University of Canterbury, Christchurch, New Zealand.

Morley, C. G. 2002: Ferret (*Mustela furo*) abundance, survival, and recruitment on farmland in North Canterbury, New Zealand. *New Zealand Journal of Zoology* 29: 23-31.

Morley, C. G. 2002L: Ferret (*Mustela furo*) abundance, survival, and recruitment on farmland in North Canterbury, New Zealand. *New Zealand Journal of Zoology* 29: 23-31.

Murphy, E. C. 1996: Ferrets as threats to conservation values. In: Ferrets as vectors of tuberculosis and threats to conservation. *Royal Society of New Zealand Miscellaneous Series* 36: 48-51.

Norbury G, Heyward, R. 1996: The response of ferrets to rabbit control. T*he Royal Society of New Zealand Miscellaneous Series* 36:30-33.

Norbury, G. 2000: The potential for biological control of stoats (*Mustela erminea*). *New Zealand Journal of Zoology* 27: 145-163.

Norbury, G. 2001: Conserving dryland lizards by reducing predator-mediated apparent competition and direct competition with introduced rabbits. *Journal of Applied Ecology* 38: 1350-1361.[Abstract]

Norbury, G. L.; Norbury, D. C.; Heyward, R. P. 1998a: Space use and denning behaviour of wild ferrets and cats. *New Zealand Journal of Ecology* 22(2): 149-159.

Norbury, G. L.; Norbury, D. C.; Heyward, R.P . 1998b: Behavioral responses of two predator species to sudden declines in primary prey. *Journal of Wildlife Management* 82: 45-58.

Norbury, G.; Heyward, R. 1995. Predator behaviour and some wider ecological issues surrounding rabbit control. *Proceedings of the 8th annual conference of the Australasian Wildlife Management Society*, Lincoln, P. 44.

Norbury, G.; Heyward, R. 1996. The response of ferrets to rabbit control. In: Ferrets as vectors of tuberculosis and threats to conservation. *The Royal Society of New Zealand Miscellaneous Series* 36: 30-33.

Norbury, G.; Heyward, R. 1997: Impact of rabbit control on predator ecology. Landcare Research contract report LC9697/138 (Unpublished).

Norbury, G.; McGlinchy, A. 1996. The impact of rabbit control on predator sightings in the semi-arid high country of the South Island, New Zealand. *Wildlife Research* 23: 93-97. [Abstract]

Norbury, G.; McGlinchy, A. 1996: The impact of rabbit control on predator sightings in the semi-arid high country of the South Island, New Zealand. *Wildlife Research* 23: 93-97.

Norbury, G.; Murphy, E. 1996: Understanding the implications of rabbit calicivirus disease for predator/prey interactions in New Zealand: A review. Landcare Research contract report LC9596/61 (unpublished)

Norbury, G.L.; Norbury, D.C.; Heyward, R.P. 1998: Behavioral responses of two predator species to sudden declines in primary prey. *The Journal of Wildlife Management* 62(1): 45-58. [Abstract]

Ogilvie, S. C.; Eason, C. T. 1998: Evaluation of iophenoxic acid and rhodamine B for marking feral ferrets (*Mustela furo*). *New Zealand Journal of Zoology* 25: 105-108.

Ogilvie, S. C.; Morgan, D. R.; Spurr, E. B.; Meikle, L. M. 1994: Development of baits for control of ferrets. Landcare Research contract report LC9495/01 (Unpublished).

Ogilvie, S. C.; Spurr, E. B.; Eason, C. T.; Young, N. 1996a: Development of a poison baiting strategy for ferrets. The *Royal Society of New Zealand Miscellaneous Series* 36: 78-84.

Ogilvie, S. C.; Spurr, E. B.; Young, N.; Eason, C. T. 1996: A field baiting strategy for the control of ferrets. Landcare Research contract report LC9596/129 (Unpublished).

Ogilvie, S.C.; Spurr, E. B.; Morgan, D. R. 1995: A bait, bait marker, toxin, and baiting strategy for the control of ferrets. Unpublished report LC9495/114, Landcare Research.

Ragg, J. R. 1997: Tuberculosis (*Mycobacterium bovis*) epidemiology and the ecology of ferrets (*Mustela furo*) on New Zealand farmland. Unpublished PhD thesis, University of Otago, Dunedin, New Zealand.

Ragg, J. R. 1998: Intraspecific and seasonal differences in the diet of feral ferrets (*Mustela furo*) in a pastoral habitat, East Otago, New Zealand. *New Zealand Journal of Ecology* 22: 113-119.

Ragg, J. R. 1998: The denning behaviour of feral ferrets (*Mustela furo*) in a pastoral habitat, South Island, New Zealand. *Journal of Zoology, London* 246: 471-477.

Ragg, J. R, Clapperton, B. K. 2004 Ferret Control Manual. Animal Health Board Project Project R-80596. Unpublished. http://www.tbfree.org.nz/ferret-control-manual-3.aspx

Ragg, J. R.; Moller, H.; Waldrup, K. A. 1995: The prevalence of bovine tuberculosis (*Mycobacterium bovis*) infections in feral populations of cats (*Felis catus*), ferrets (*Mustela furo*) and stoats (*Mustela erminea*) in Otago and Southland, New Zealand. New Zealand Veterinary Journal 43: 333-337.

Ragg, J. R.; Waldrup, K. A.; Moller, H. 1995: The distribution of gross lesions of tuberculosis caused by *Mycobacterium bovis* in feral ferrets (*Mustela furo*) from Otago, New Zealand. *New Zealand Veterinary Journal* 43: 338-341.

Robson, D. L. 1993: Natural mortality of juvenile rabbits (*Oryctolagus cuniculus*) in North Canterbury, New Zealand. Wildlife Research 20: 815-831.

Rutherford, D. 1996. Experience on Melrose. In: Ferrets as vectors of tuberculosis and threats to conservation. *Royal Society of New Zealand Miscellaneous Series* 36: 70-71.

Rutherford, D. 1996: Experience on Melrose. In: Ferrets as vectors of tuberculosis and threats to conservation. *Royal Society of New Zealand Miscellaneous Series* 36: 70-71.

Smith, G. 1994: Ferret (*Mustela furo*) diet in relation to prey abundance and Tb infection in pastoral habitat of Otago. Unpublished wildlife management report 57, University of Otago, Dunedin, New Zealand.

Smith, G. P.; Ragg, J. R.; Moller, H.; Waldrup, K. A. 1995: Diet of feral ferrets (*Mustela furo*) from pastoral habitats in Otago and Southland, New Zealand. *New Zealand Journal of Zoology* 22: 363-369.

Spurr, E. B., O'Connor, C. E., Byrom, A. E., 2001: Review of research on improving the effectiveness of ferret control in winter and spring. *Proceedings of the 12th Australasian Vertebrate Pest Conference*: 353-357.

Spurr, E. B.; Ragg, J. R.; O'Connor, C. E.; Hamilton, W. J.; Moller, H.; Morse, C.W.; Morriss, G. A.; Arnold, G.C.; Clapperton, B.K. 2003: Anal gland scent as a novel, cost-effective method of attracting ferrets. Landcare Research Contract Report LC0203/xx (unpublished and in process).

Spurr, E. B.; Ragg, J. R.; O'Connor, C. E.; Moller, H.; Morse, C. W. 2000: Seasonal constraints on ferret control. LC9900/112/Ecosystem Consultants Landcare Research contract report (Unpublished).16pp.

Spurr, E.B.; Airey, A.T.; O'Connor, C.E. 2001: Feratox paste for ferrets. Landcare Research contract report LC0102/50 (unpublished). 11 p.

Spurr, E.B.; Morse, C.W.; Eason, C.T. 1997b. Poison-baiting of ferrets in winter. Landcare Research contract report LC9798/67 (unpublished), 15 p.

Spurr, E.B.; O'Connor, C.E.; Rhodes, A.T.; Eason, C.T. 1999: Feratox® for ferrets. Landcare Research contract report LC9900/25 (unpublished). 14 pp.

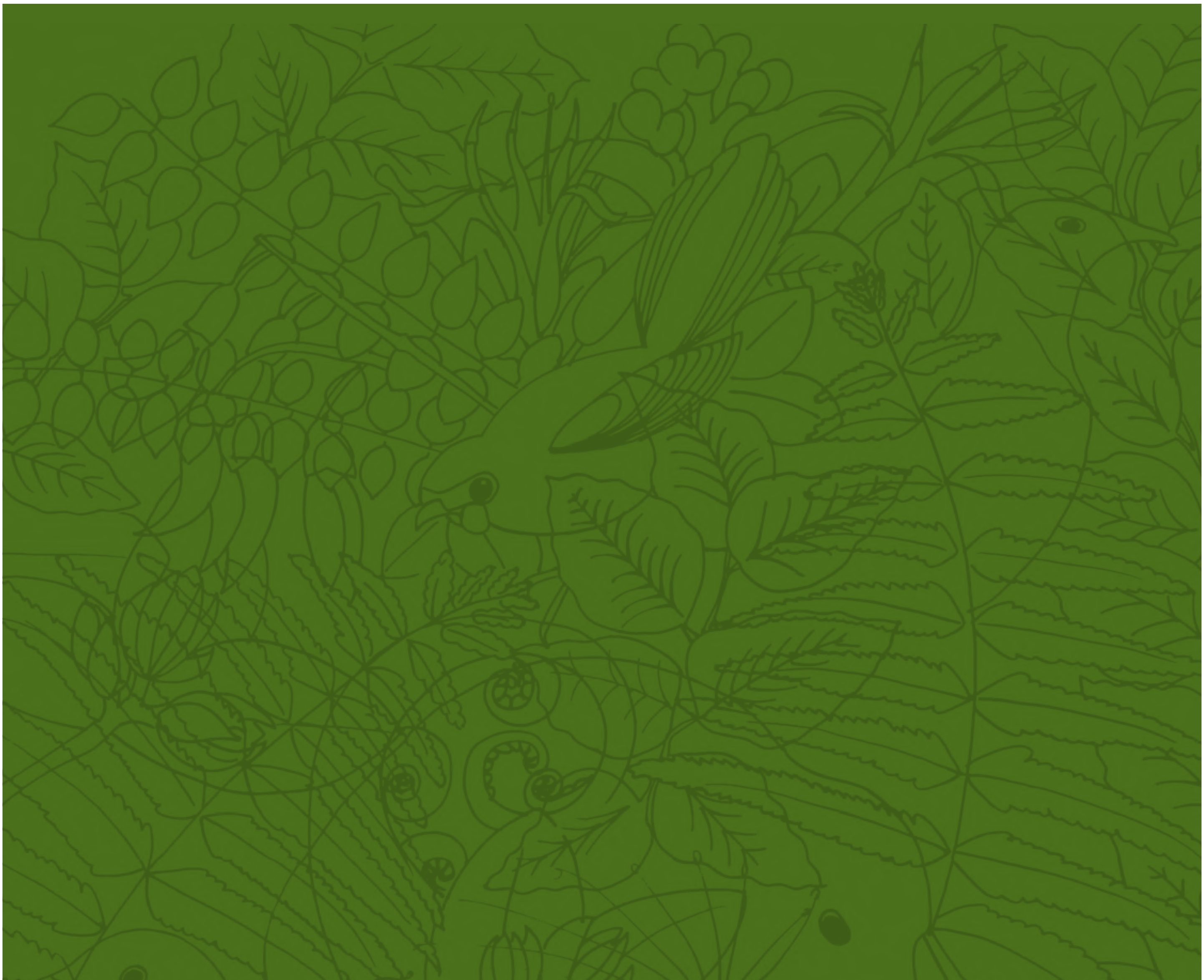
Spurr, E.B.; Ogilvie, S.C.; Eason, C.T.; Morse, C.W.; Young, J. 1997a. A poison-baiting strategy for effective ferret control. Landcare Research contract report LC9697/135 (Unpublished), 17 p.

Spurr, E.B.; Ragg, J.R.; O'Connor, C.E.; Moller, H.; Morse, C.W. 2000: Seasonal constraints on ferret control. Landcare Research contract report LC9900/112 (unpublished). 24 pp.

Walker, R.; Reid, B. T.; Crews, K. B. 1993: Bovine tuberculosis in predators in the Mackenzie Basin. *Surveillance* 20: 11-14.

Warburton, B.; Poutu, N.; Domigan, D. 2002: Evaluation of the effectiveness of four commercially available traps for killing ferrets. Landcare Research Contract Report LC0203/003 (unpublished).

Young, J. B. 1998: Movement patterns of two New Zealand mustelids: Implications for predator pest management. Unpublished MSc thesis, Lincoln University, Lincoln, New Zealand.



c/- info@bionet.nz

National Pest Control Agencies