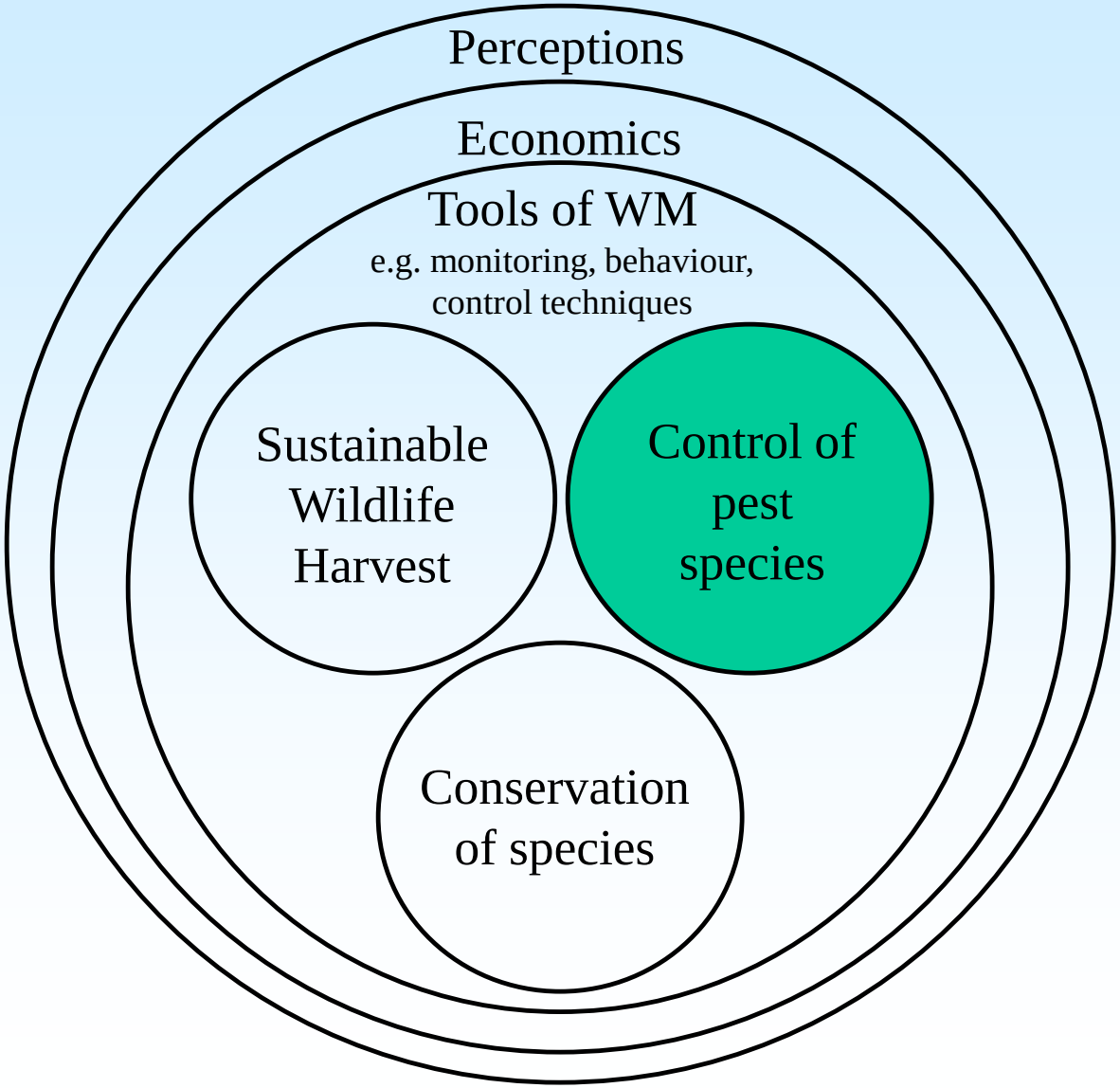
Introducing the

Centre for Wildlife Management and Conservation

Lincoln University

Dr James Ross
Senior Lecturer, Department of Ecology

Wildlife Management



Main Pests

Stoat (*Mustela erminea*)

Possum (*Trichosurus vulpecula*)

Ship rat (*Rattus rattus*)

- New Zealand is a unique situation with numerous introduced mammalian pest species.

Feral cat (*Felis catus)*

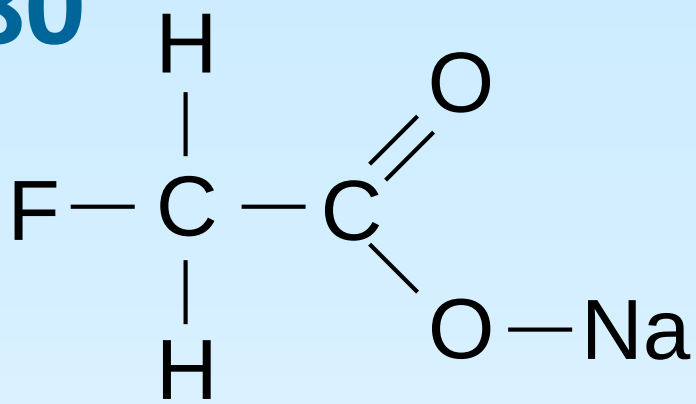
Control options

- Once the “control” objective has been decided, there are a number of tools available:
  - Exclusion, banding, deterrents.
  - Hunting, shooting.
  - Trapping.
  - Toxicants.
  - Biological control.

Toxicants

- Currently 8 toxicants registered in NZ for possum control:
  - Compound 1080. **Zinc Phosphide! PAPP! Sodium Nitrate!**
  - Brodifacoum.
  - Cyanide (disrupts oxygen metabolism).
  - Cholecalciferol (vitamin D3, elevates blood [Ca], heart failure).
  - Phosphorus (forms phosphide gas, disrupts respiration).
  - Pindone (anticoagulant).

Compound 1080



- Sodium monofluoroacetate
  - Small molecule $C_2H_2NaFO_2$
- In pure form is a light, fine white powder, water soluble.
- Disrupts krebs cycle:
  - Cells lose energy production capability.
- 1080 is aerially applied in bait. Will talk about this in later lectures.

The Ideal Toxin

Attributes	1080
Inexpensive	Yes - $0.08/possum
Antidote	No – under development
Degradable	Yes – will biodegrade in soil and water
Species specific	No – most mammals susceptible
Humane	? – debatable
Non-persistent in livestock	Yes – fluoroacetate quickly metabolised
Low risk of primary poisoning	? – low risk of large mammal death
Low risk of secondary poisoning	No – carnivores at risk from carcasses
High public acceptance	No – is this the major issue?
Comprehensive database of toxicology	? – registered for use in USA

Public Perception

The Brushtail Possum: Biology, impact and management of an introduced marsupial

Table 17.2
Acceptability of various methods for killing possums (n=1127).

Method	% of respondents			
	unacceptable	neutral	acceptable	don't know or don't understand
Manual methods				
shooting	8	10	82	<1
trapping	17	7	67	<1
Poisoning methods				
possum-specific poison	18	12	68	2
ground laying of 1080	43	18	36	3
aerial drops of 1080	54	17	27	2
other poisons	52	17	27	4
Biological methods				
genetically engineered organism (GMO)	30	14	45	11
imported possum-specific parasite	35	16	35	14
imported possum-specific bacterium	37	18	29	15
imported possum-specific virus	39	17	29	15

Respondents rated the methods on a 5-point scale, from "very unacceptable" (1) to "very acceptable" (5). "Unacceptable" ratings were 1 and 2; "acceptable" ratings were 4 and 5.

Source: Montague, T.L. 2000. *The brushtail possum*. Manaaki Whenua Press, NZ.

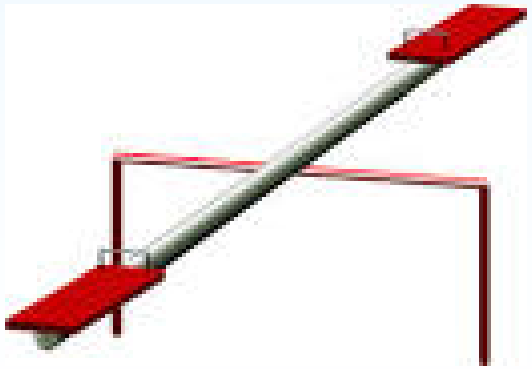
The Knife Edge Challenge in Possum Control

Benefits

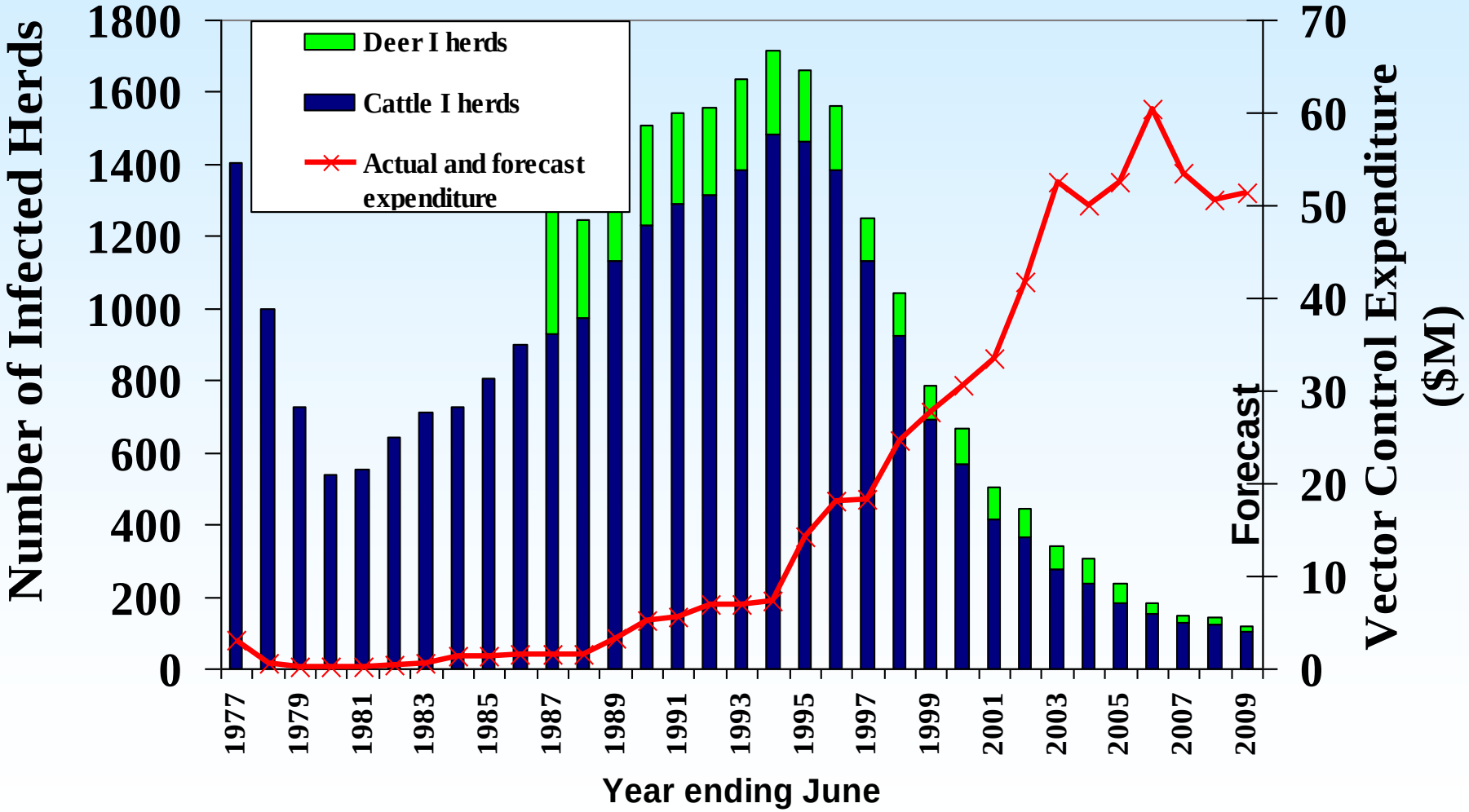
- Conservation
- TB reduction
- Protection of forest and crops

Risks

- Non-target wildlife
- Environmental contamination
- Domestic Animals, Human Health



Number of infected cattle and deer herds and expenditure on vector control 1977 - 2009



Benefits of Possum Control to Flora

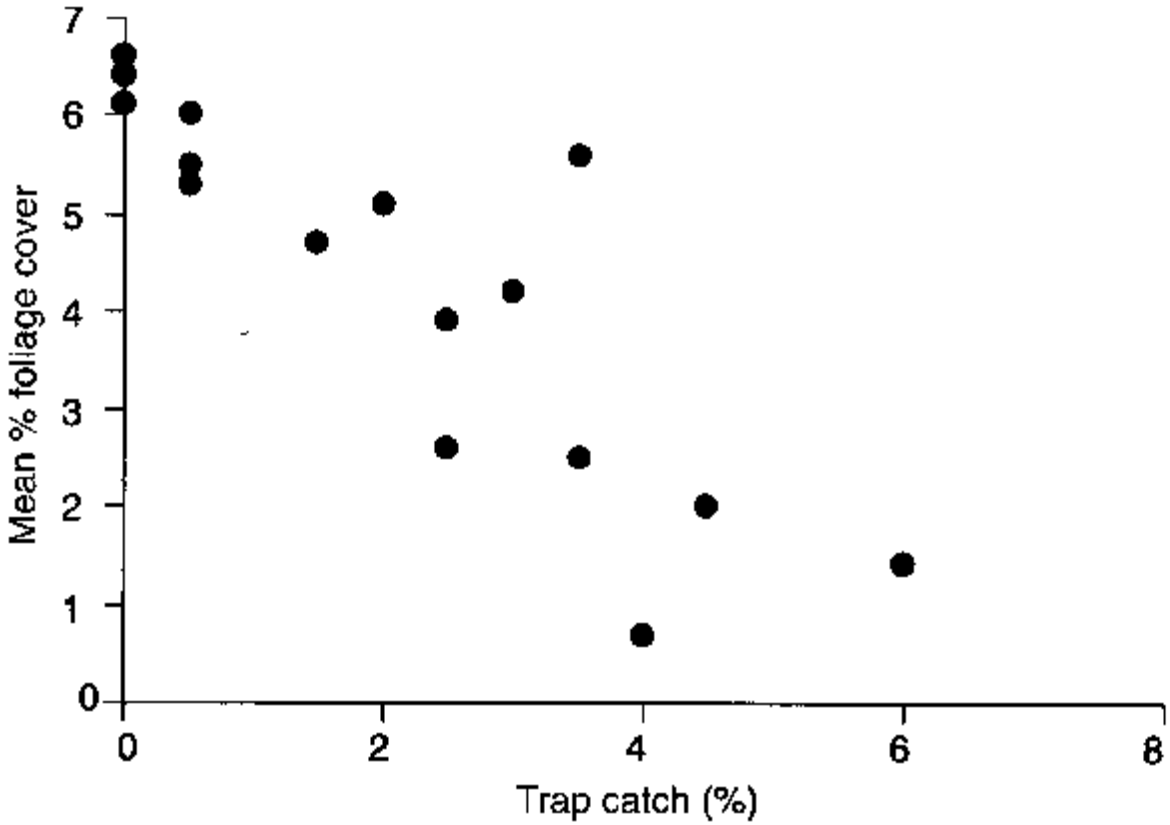


Fig. 21.2
Relationship between *Fuchsia excorticata* foliage cover and possum trap-catch rates for five study sites over 4 or 5 years (Pekelharing *et al.* 1998).

235

Source: Montague, T.L. 2000. *The brushtail possum*. Manaaki Whenua Press, NZ.

Benefits to Fauna

Source: Powlesland, R.G., Knegtmans, J.W., & Marshall, I.S.J. (1999) Costs and benefits of aerial 1080 possum control operations using carrot baits to North Island robins (*Petroica australis longpipes*), Pureora Forest Park. New Zealand Journal of Ecology, 23, 149-159.

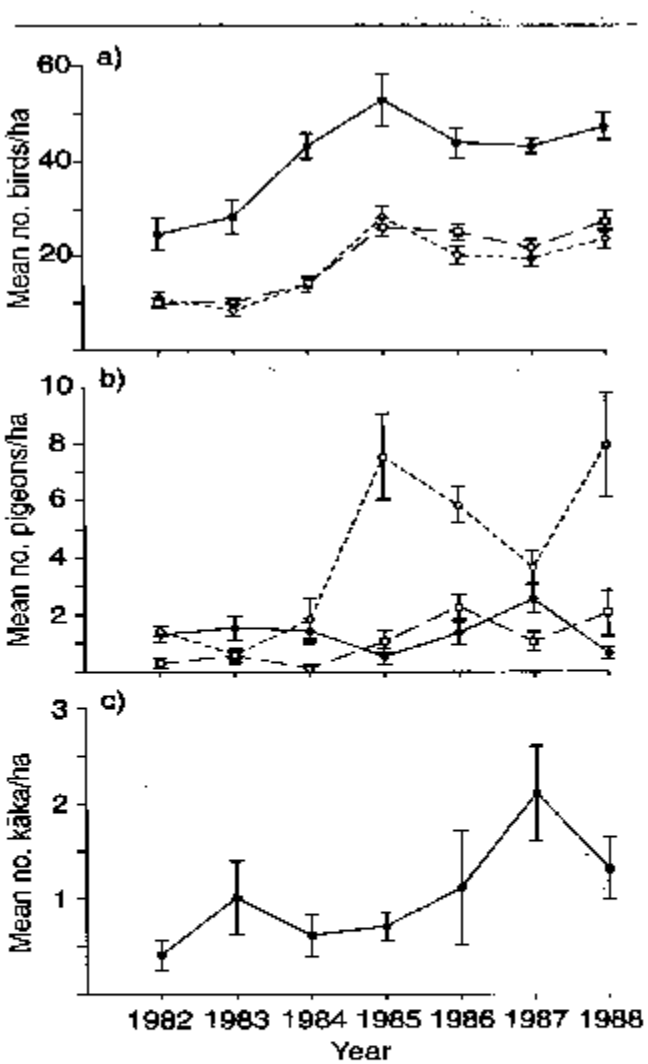
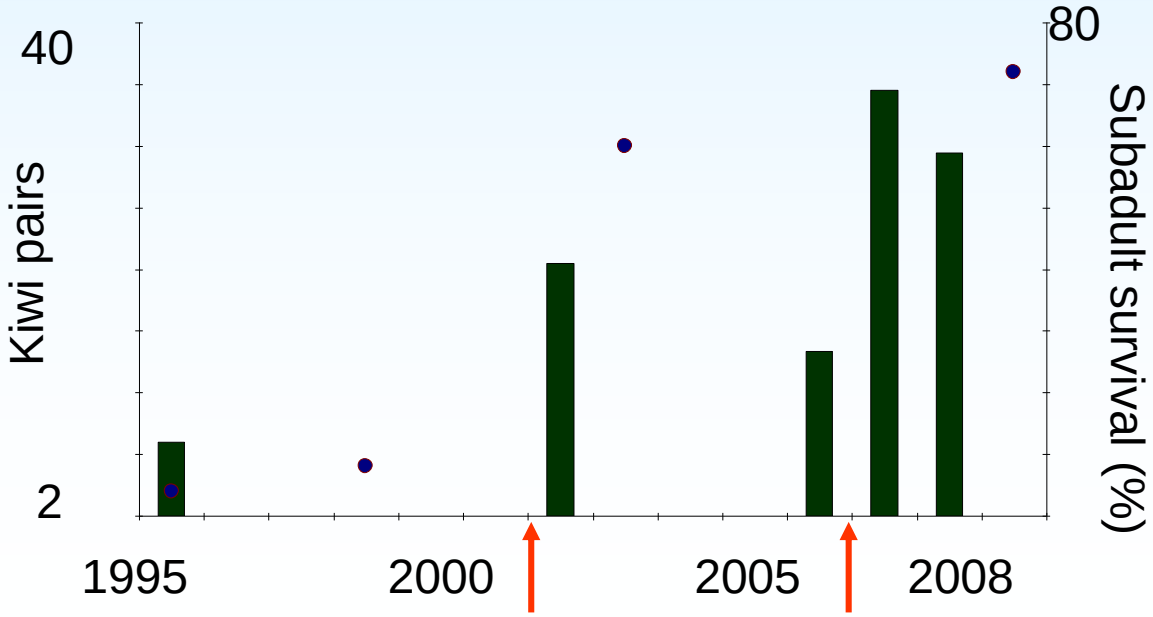


Fig. 22.3
(a) Mean total bird numbers per hectare on Kapiti Island from 1982 to 1988. Possum eradication was completed in 1986. (● — Transect 1; ○ — Transect 2; □ — Transect 3). (b) Mean number of New Zealand pigeons per hectare on Kapiti Island from 1982 to 1988. (● — Transect 1; ○ — Transect 2; □ — Transect 3). (c) Mean number of kākā per hectare along Transect 1 in coastal forest on Kapiti Island from 1982 to 1988. Data provided by T. Lovegrove, Auckland Regional Council.

Kiwi-Tongariro-1080-predators



RISK = HAZARD X EXPOSURE

Hazard (toxicity)
- acute
- sub-lethal

Exposure
- Direct
- Indirect
  - secondary poisoning
  - soil, plants, water, dust contamination

Acute toxicity

Species	LD_{50} mg/kg
Dog	0.07
Rat	0.2
Sheep	0.25
Possum	1.0
Duck	9.0
Weta	90

- 1080 is broad spectrum
- hazardous to most/all species

Child 15 kg 1-2 baits

Adult 70 kg 4-8 baits

Birds most at risk?

Survival of radio-tagged birds after aerial 1080 operations

Bird species	Total with radio-tags	Bird deaths	Bait type used
Brown kiwi	61	0	Cereal
great spotted kiwi	16	0	Cereal
Weka	32	1	Cereal
Morepork	7	0	Cereal
Kaka	57-62	0	Cereal
Morepork	6	1	Carrot
Blue duck	19	0	Carrot
Kaka	38	0	Carrot
Kereru (pigeon)	15	0	Carrot

Bird Mortality

- Many operational improvements have occurred since 240 native birds, mostly insectivorous species, were found dead after four aerial 1080 operations in 1976 and 1977.

- Those operations had all used poor quality baits – undyed, raspberry-lured, unscreened carrot baits, with a very high percentage of “chaff”.

Bird Mortality

- Some 40% by weight of the carrot was small fragments (chaff) of less than one gram, which were both extremely numerous and lethal to small birds. Screens now remove pieces of carrot weighing less than two grams.

- Raspberry lure is banned, carrot baits must be dyed green and the addition of cinnamon flavor deters birds while masking the 1080 odor to possums.

Aerial Refinement

- Between 1978 and 1993, extensive monitoring after 70 aerial 1080 operations, using screened carrots or cereal-based baits, found a total of 83 dead birds, of which 34 were native species.

- Blackbirds and tomtits were the species most commonly found dead. This was less than one detected native bird death per operation. Monitoring surveys indicate that few bird deaths occur from aerial 1080 operations as long as “best practices” are followed.

Key Points! Non-target birds and 1080

- Individual birds can be killed. Fewer losses with cereal pellets.
- Successful possum control should reduce predation/ competition and increase bird breeding success.
- A recent study of five operations in the North Island tested the impacts of cereal and carrot baits on tomtits, using sowing rates of 3-5 kg/ha. It confirmed that 12 g cereal baits had little, if any, immediate impacts on tomtit populations at these sowing rates.

What About……?

Kea killed in 1080 operation

ASHLEIGH STEWART

Last updated 17:59 21/08/2013

16 Share 964 Tweet 5 G+1 Share

ENDANGERED: Five keas died after the study used a bird repellent in an aerial 1080 operation near Arthur's Pass earlier this month.

Five kea have been killed in Arthur's Pass in a 1080 operation attempting to protect the endangered and protected species.

The Department of Conservation (DOC) are currently investigating ways to protect the kea during 1080 operations, after the first field study yielded "disappointing results".

The study used a bird repellent in an aerial 1080 operation near Arthur's Pass earlier this month, killing five of 39 monitored birds.

The deaths come after seven kea were killed at Fox Glacier after eating 1080 poison in 2008, wiping out almost half a group of the endangered parrot being monitored by DOC.

A new baiting protocol was introduced in 2010 to reduce the risk to kea, which included using less palatable baits and avoiding open areas above the bush line.

However, DOC continues to maintain that pest control using 1080 benefits birds, including kea, by improving nesting success and the survival of adult females.

1080 drop may have killed rare birds

HELEN MURDOCH
Last updated 05:00, January 19 2015

DAVID HALLETT

POISON FEARS: A 1080 drop may have hurt a population of endangered bird the rock wren in the South Island's Kahurangi National Park.

The Battle for our Birds campaign may have almost wiped out a population of the very species it aimed to protect in Kahurangi National Park.

The $10 million national operation involved more than 800 tonnes of 1080 poison being dropped across parts of the country last year in response to an expected heavy beech seeding predicted to drive up mice and rat numbers that would in turn boost the stoat population.

Before Christmas the Department of Conservation (DOC) said it could not find 25 rare and endangered rock wren in the Grange Range of the Tasman Wilderness Area in Kahurangi National Park, which was subject to a 1080 drop for the first time in October.

Rock Wren

- There is still no clear evidence as to why rock wren being monitored in Kahurangi National Park went missing after unseasonable weather and snow and the pest control operation last spring.

- While some birds were probably lost to 1080, early counts indicate the high nesting success due to stoat control has already balanced this out with 61 birds estimated in the area after the operation was carried out compared with 49 birds before hand.

- The full effects of aerial 1080 pest control on rock wren won’t be known until the end of next summer when the birds have another chance of breeding with reduced stoat numbers.

Kea

- Since 2008, 155 kea have been monitored through ten 1080 operations, with 20 (12.9 per cent) recorded fatalities, DOC says.

- Kea are particularly inquisitive and DOC has been researching ways to minimise the loss of individual kea in 1080 operations.

Long-Term

- Since 2008, 155 kea have been monitored through ten 1080 operations with 20 (12.9%) recorded fatalities.

- Recent research at Okarito showed that following the 1080 pest control operation in 2011 kea nesting success in the treated area increased from 51% to 100%. Nesting success of 38% was recorded in a nearby untreated area. The following year 69% of nests in the treated area succeeded, compared to 1% in the untreated area.

How Can You Repel Birds?

- A <u>secondary</u> repellent differs from a <u>primary</u> repellent in that discomfort or illness occurs some time after consumption.

	Back-transformed/scaled means	
	Encounters	Eaten/removed
Yellow	3.62a	4.79a
Brown	2.44ab	2.35b
Red	2.08bc	2.39b
Mid-blue	1.47bcd	1.25bc
Dark-blue	1.41cd	1.01cd
Green	0.85d	0.48d

Table 1. Back-transformed and scaled means resulting from the GLMM for the number of encounters and pieces eaten/removed of each colour offered to kea. Mean values that do not share any letter are significantly different at $P<0.05$ (Fisher's LSD test).

Primary Repellents

- DOC is investigating two bird repellents d-pulegone and 9, 10 anthraquinone—for use in 1080 operations. Both compounds have been trialed with other birds in New Zealand and overseas.

- D-pulegone is a food additive based on the peppermint flavour found in some plants in the mint family. Birds have been shown to be irritated by its odour and taste.

Primary Repellent

Stability of bird repellents used to protect kea (*Nestor notabilis*) during aerial 1080 cereal operations

Michelle Crowell[1]*, Lynn Booth[2], Phil Cowan[2], Alastair Fairweather[1] and Ian Westbrooke[1]

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Published online: 9 September 2015

Abstract: Aerial poisoning with cereal bait containing 1080 toxin is known to pose a risk to the kea (*Nestor notabilis*), an endemic New Zealand mountain parrot. For a bird repellent to protect kea during such poisoning operations, it must be effective in bait for 4–12 weeks after the bait is manufactured, as this is when most aerial 1080 cereal operations take place. Two bird repellents have been shown to be effective with captive kea, d-pulegone and 9,10-anthraquinone. The stability of d-pulegone required further investigation because previous monitoring showed d-pulegone declined to very low levels in cereal baits 30 weeks after manufacture. Repellents were incorporated as ingredients during the normal bait manufacturing process. The estimated initial concentrations of d-pulegone in five batches of non-toxic prefeed bait and four batches of toxic bait at manufacture were only 52–88% of the nominal concentration. The superheated steam that was used to condition bait ingredients probably contributed to d-pulegone loss during manufacture. Thereafter, the estimated rate of decay of d-pulegone in storage ranged from 3.2% to 6.6% per week, so none of the batches of bait met the operational target concentration of 0.12–0.22% wt/wt at 4–12 weeks after manufacture. By contrast, the concentration of anthraquinone on receipt in one batch of repellent toxic baits was very close to the nominal concentration and did not decline over a 6-month period. Future research on d-pulegone should investigate stabilisation, following which the effectiveness of d-pulegone as a bird repellent should be retested, either alone at a higher concentration or in combination with a 'secondary' repellent. Future research on anthraquinone in cereal pellets should focus on possum control, as indications are that rat kills are adversely affected by its use in cereal baits.

What About the New Toxins?

- Persistent compounds (anticoagulants)
- Some poisons inhumane or unpopular
- Tools that communities can use

- Gap between refining/optimising 1080 use & aspiration for biocontrol
- Take some pressure off 1080
- More tools in tool box
- Providing a more advanced generation of toxins

NO NEW VTA's SINCE 1980s

New toxins, delivery systems, monitoring systems and traps

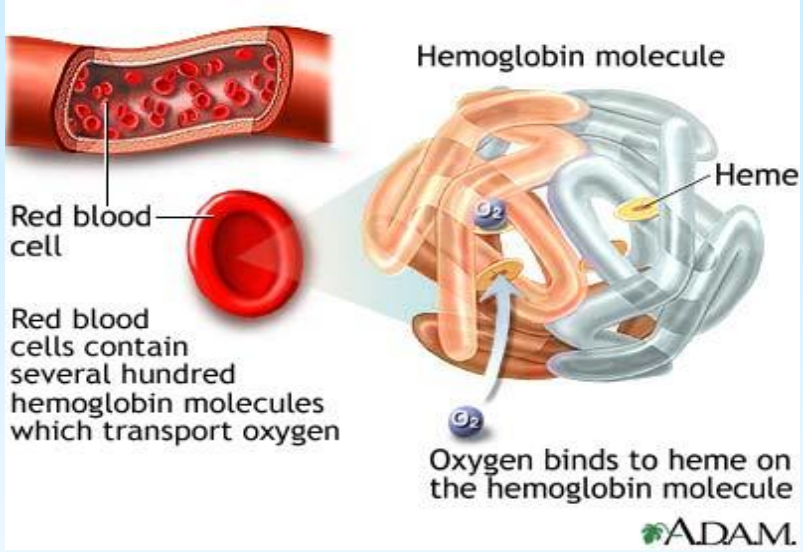
Focus …. i) extending the registration of acceptable "low residue" tools

ii) new toxins

iii) then linking new toxins to new baits and re-settable delivery systems new toxins

1st Generation RBC toxins

- Para-aminopropiopenone (PAPP) and sodium nitrite (SN)



- PAPP for stoats, feral cats (NZ) and foxes (Aus)
- SN targeted possums (NZ) and feral pigs (Aus)

North Island feral cat field trial

- 1500 ha block Ngamatea station
- 22 pre-feeding sites set up & monitored
- 21 radio-tx & 3 un-collared

Key features NI field trial

- 5 PAPP baits station for 5 nights
- 40 mg PAPP
- Of 21 radio-tx cats – 1 died before trial & 4 left area after being collared

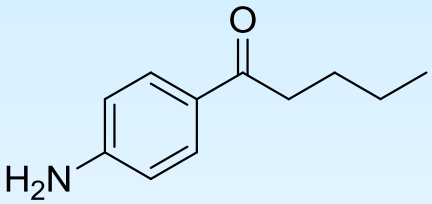
Feral cat trial completed –June 09

Results

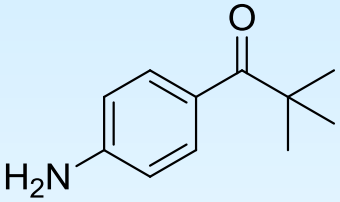
- 13/16 died
- 3 monitored un-collared cats died
- 16/19 (84%) monitored cats died
- dead cats 123 m from bait stations

Stoat Spitfire

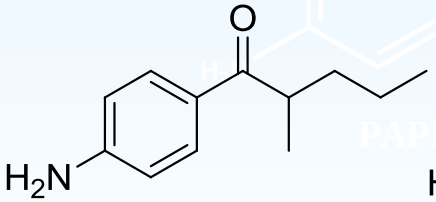
Analogues of PAVP



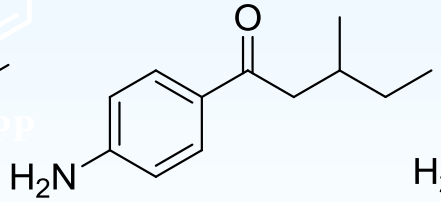
PAVP DC054
MetHb(%) = 58.1



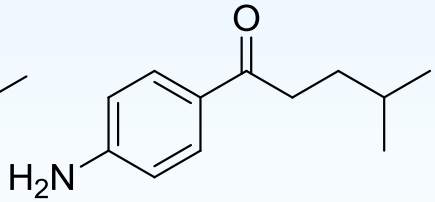
2,2-Dimethyl PAPP DC093
MetHb(%) = 54.2



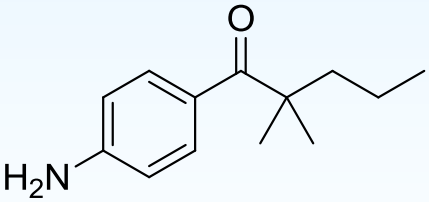
2-Methyl
PAVP



3-Methyl
PAVP



4-Methyl
PAVP



2,2-Dimethyl
PAVP

Charlie → Duncan (from Dr R. T. Fox Middlemore Hospital!)

PUBLIC HEALTH

Methaemoglobinaemia following ingestion of a commonly available food additive

Peter Maric, Sayed S Ali, Leon G Heron, David Rosenfeld and Matthew Greenwood

Five cases of methaemoglobinaemia after ingestion of sodium nitrite occurred in two clusters in Sydney in 2006. All cases were unintentional poisonings following use in cooking of an imported compound sold as a food additive. In all cases, methaemoglobinaemia was recognised early and treated promptly, with all patients making a full recovery. These cases highlight the importance of accurate food labelling and surveillance of imported goods. (MJA 2008; 188: 156-158)

Vietnamese family unrelated to the index cases, presented to Liverpool Nutre Powder was imported via Victoria, the Victorian Department

NZHerald August 2006

Auckland man was almost killed by a plate of poisoned meatballs The "deadly meatballs" level of preservative sodium nitrite was X 344 times permitted level for cured meats…. meatballs had 43,000mg/kg; the maximum permitted is 25mg/kg….”tasted bitter had to add heaps of tomato sauce”(JAFA)

Victim nearly died after poison meatballs

Butcher’s helper heaped in preservative instead of flavouring

by Martin Johnston
health reporter

An Auckland man was almost killed by a plate of poisoned meatballs which he bought from his local butchery. The meatballs had been accidentally poisoned by a kitchen hand who thought he was adding flavouring.

The 47-year-old South Auckland man had been playing cards with friends and ate microwaved meatballs for an evening meal. About an hour later he vomited and lost consciousness. Family members returned home to find him unconscious and he was taken by ambulance to Middlemore Hospital.

He had turned blue and was severely short of oxygen. Doctors diagnosed a potentially fatal condition in which the blood’s oxygen-carrying capacity was reduced by nitrites affecting the haemoglobin in the red blood cells. He was treated with an infusion of a chemical antidote, made a full recovery and was discharged after three days.

Meanwhile, his daughter found the leftover meatballs in the fridge and they were sent for scientific analysis, according to a report in the latest *New Zealand Medical Journal*.

The analysis revealed a level of the preservative sodium nitrite which was 344 times the permitted level for cured meats under the Australia-New Zealand Food Standards Code. The meatballs had 43,000mg/kg; the maximum permitted is 125mg/kg.

A product recall was initiated and an Auckland Regional Public Health Service investigation traced the meatballs to a local butchery.

The “deadly meatballs”, as the journal described them, were among 56 made by the butchery two days before the man ate them.

The main ingredients were meant to be minced meat and powdered flavouring, but a mistake resulted in the preservative overload.

“A bag of nitrite powder labelled ‘poison’ was kept alongside the bag of flavouring powder,” the man’s doctors and a public health officer, Dr Greg Simmons, said in the journal.

“A worker who knew very little English made the meatballs for the first time on that occasion, with verbal instruction from a co-worker. He added 500g of nitrite to the mineral meat instead of flavouring, not knowing the meaning of the word ‘poison’ written on the bag.”

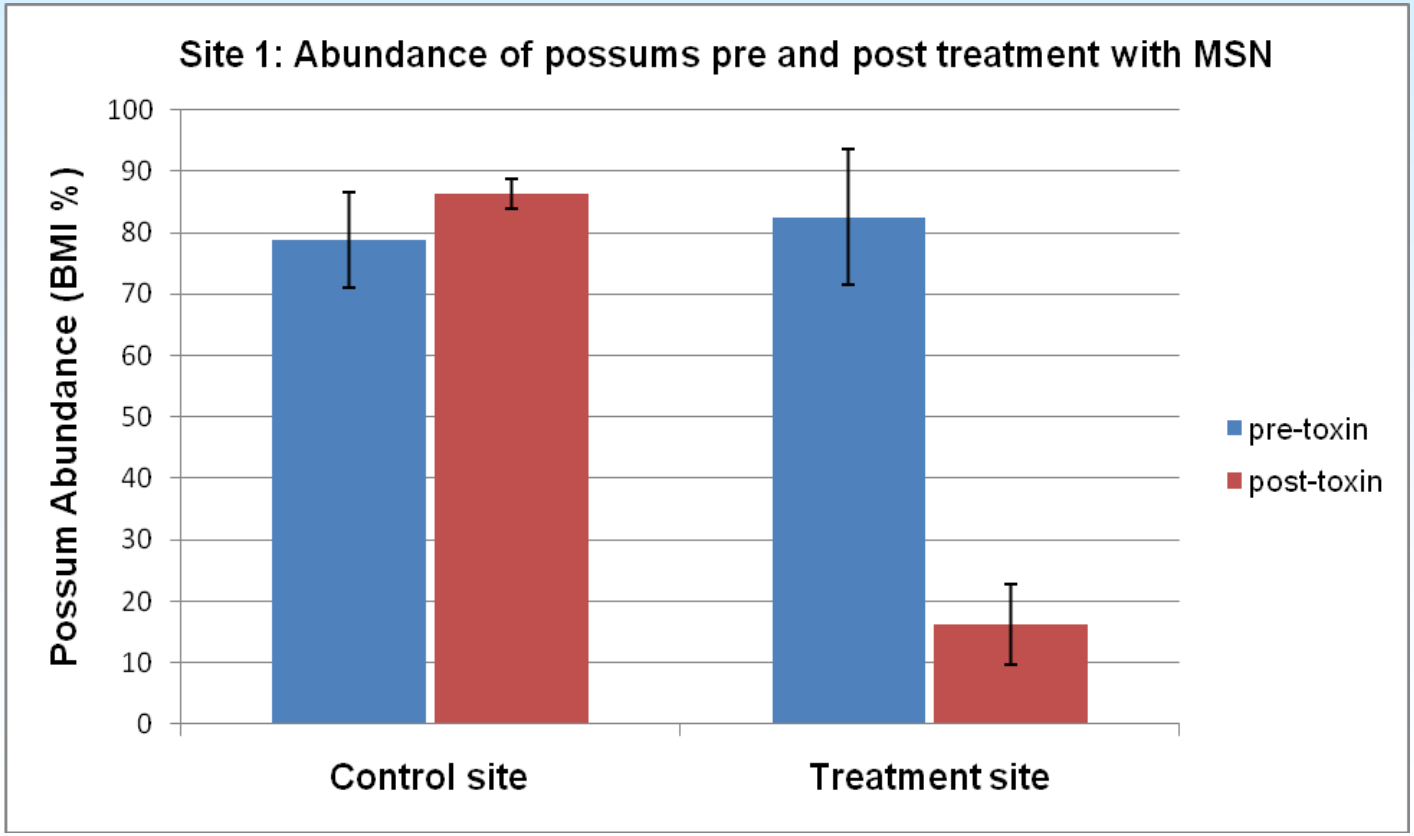
The patient had bought about eight meatballs and about 16 were bought by a woman who reported no ill effects from consumption. None were returned after the recall notice and 32 were not accounted for.

“This case highlights the need for care in the use of chemical food preservatives, and it emphasises the importance of staff training where potentially toxic food additives are used,” the journal report says.

The Food Safety Authority is prosecuting the butchery and one of its directors over the case. The authority’s director of compliance and investigation, Geoff Allen, said yesterday they had both pleaded guilty to two charges under the Food Act relating to putting human health at risk. The charges carry a maximum penalty of up to a year’s jail or a fine of up to $100,000.

The defendants are scheduled to be sentenced in the High Court at Auckland next week.

Promising result in 1st possum field trial with sodium nitrite- more trials planned 2010/11



ANIMAL HEALTH BOARD

Risk to Mammals

Table 1: Oral LD_{50} values available for PAPP on a range of animal species

Animal	LD_{50} mg/kg (95% C.I.)	Reference
Cat	5.6	Savarie *et al*, 1983
Stoat	9.3	Fisher *et al,* 2005
Coyote	5.6	Savarie et al, 1983
Bobcat	10	Savarie et al, 1983
Kit fox	14.1	Savarie et al, 1983
Ferret	29	O'Connor, 2002
Dog	26 - 43	Murphy *et al*, 2007
Dog (*Canis familiaris*- male)	30-50	Vandenbelt *et al.* 1943
Wallaby	89	O'Connor, 2002
Rat (*Rattus Norvegicus* - male)	177 (119-262)	Savarie *et al*, 1983
Rat (Swiss Webstar)	221	Pan *et al*, 1982
Mouse (*Mus musculus* - male)	233 (186-292)	Savarie *et al*, 1983
Rat (female)	224 (169-308)	Scawin *et al,* 1984
Rat (male)	475 (89-2525)	Scawin *et al*, 1984
Mouse (female)	> 5000	Scawin *et al*, 1984
Possum	≥ 500	O'Connor, 2002
Guinea pig	1020 (760-1520)	Scawin *et al*, 1984

Risks to Birds

Table 2: PAPP oral LD_{50} values for bird species

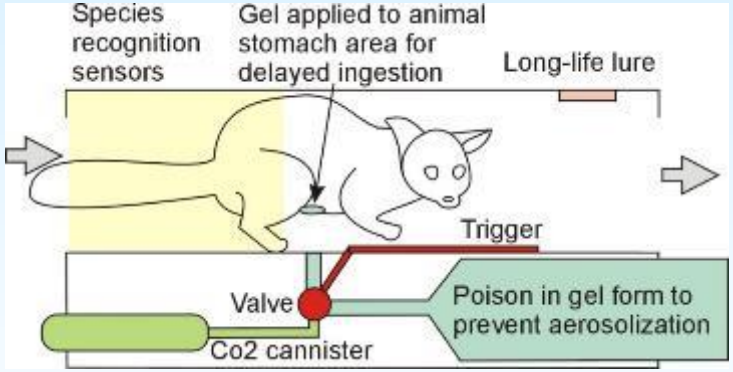
Avian Species	LD_{50} (mg/kg)	Reference
Duck (Pekin, mallard)	32	Eason et al.
Duck (Pekin, mallard)	~38	O'Connor, 2002
Eagle	> 50	Savarie *et al*, 1983
Blackbird	174	Eason et al.
American crow	178	Schafer *et al*, 1983
Blackbilled magpie	178	Schafer *et al*, 1983
Crow	>178	Savarie *et al*, 1983
Magpie	178	Savarie *et al*, 1983
Magpie	~1300	Eason et al.
Quail	316	Schafer *et al* 1983
Quail	> 316	Savarie *et al*, 1983
Starling	316	Schafer *et al* 1983
Starling	> 316	Savarie *et al*, 1983
Weka	568*	Eason et al
Australian magpie	1387	Eason et al

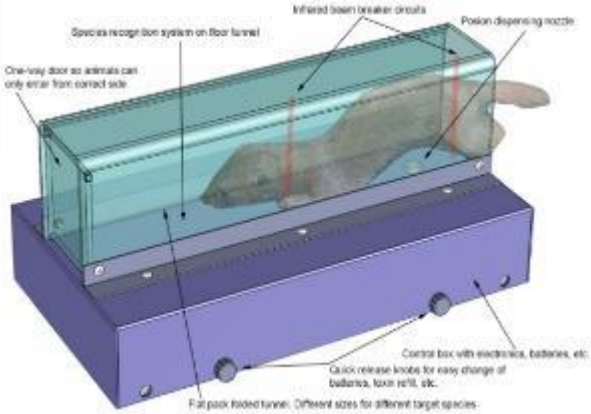
Application Methods

MK 1: Stoat, possum and rodent toxin delivery- (and rabbits?)

MK 2:
This series adds a counter to the device

MK3:
This series incorporates species recognition





Summary

- Refinement of repellents should help to reduce non-target by kill.
- Recently registered toxins have low toxicity for birds.
- Refinement of delivery methods should also help reduce future risk to NZ birds.

Refs

Weser, C. & Ross, J. (2012). The effect of colour on bait consumption of kea (Nestor notabilis): Implications for deterring birds from toxic bait. New Zealand Journal of Zoology. http://dx.doi.org/10.1080/03014223.2012.710639

Saxton, V., Mulder, I., Creasy, G., Paterson, A., Ross, J., & Trought, M. (2010). Comparative behavioural responses of silvereyes (*Zosterops lateralis*) and European blackbirds (*Tyurdus merula*) to secondary metabolites in grapes. *Austral Ecology*. http://dx.doi.org/10.1111/j.1442-9993.2010.02142.x

Ross, J.G. (2001). Assessing the risks to birds during possum control. National Technology Seminar. National Possum Control Agencies, 11th-12th December, Wellington.

Ross, J.G., Henderson, R.J. & McGaw, S. (2006). Assessing Bird Responses to Cereal and Carrot Baits Coated with Deer Repellent. Unpublished Landsdowne Ventures Contract Report (Project R-80568-06) prepared for the Animal Health Board Inc. 16 p.

Ross, J.G., Henderson, R.J. & Griffiths, J.W. (2002). Measuring interference with possum bait by native birds. Unpublished Pest-Tech Contract Report No. PS2002/08 prepared for the Animal Health Board Inc. 12 p.

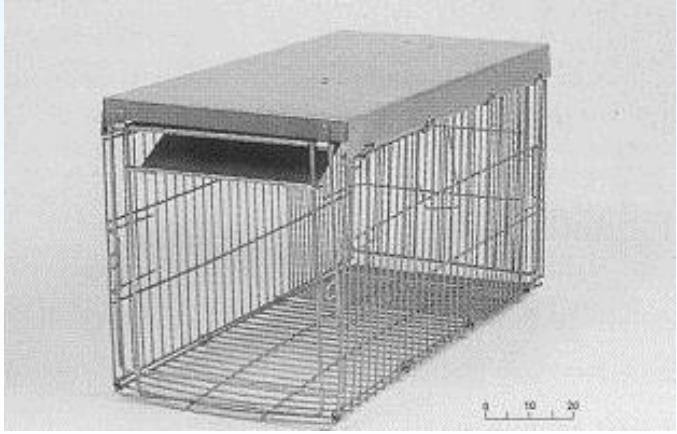
Ross, J.G., Frampton, C.M. & Gardner, P. (2002). Assessing bird interference with apple baits. Unpublished Pest-Tech Contract Report No. PS2002/07 prepared for the Animal Health Board Inc. 12 p.

KILL TRAPS

- There has been research on kill traps – however, these remain an expensive option (labour costs).

Trapping

- A large number of trap types currently used for the control of vertebrate species in NZ.
- Two broad categories, capture or kill.
- For the purposes of this lecture will explore welfare issues of kill traps.



Capture trap –Grieve wire

Kill trap –LDL101

Ferret 3-min test

Timms

KBL Tunnel

Tunnel

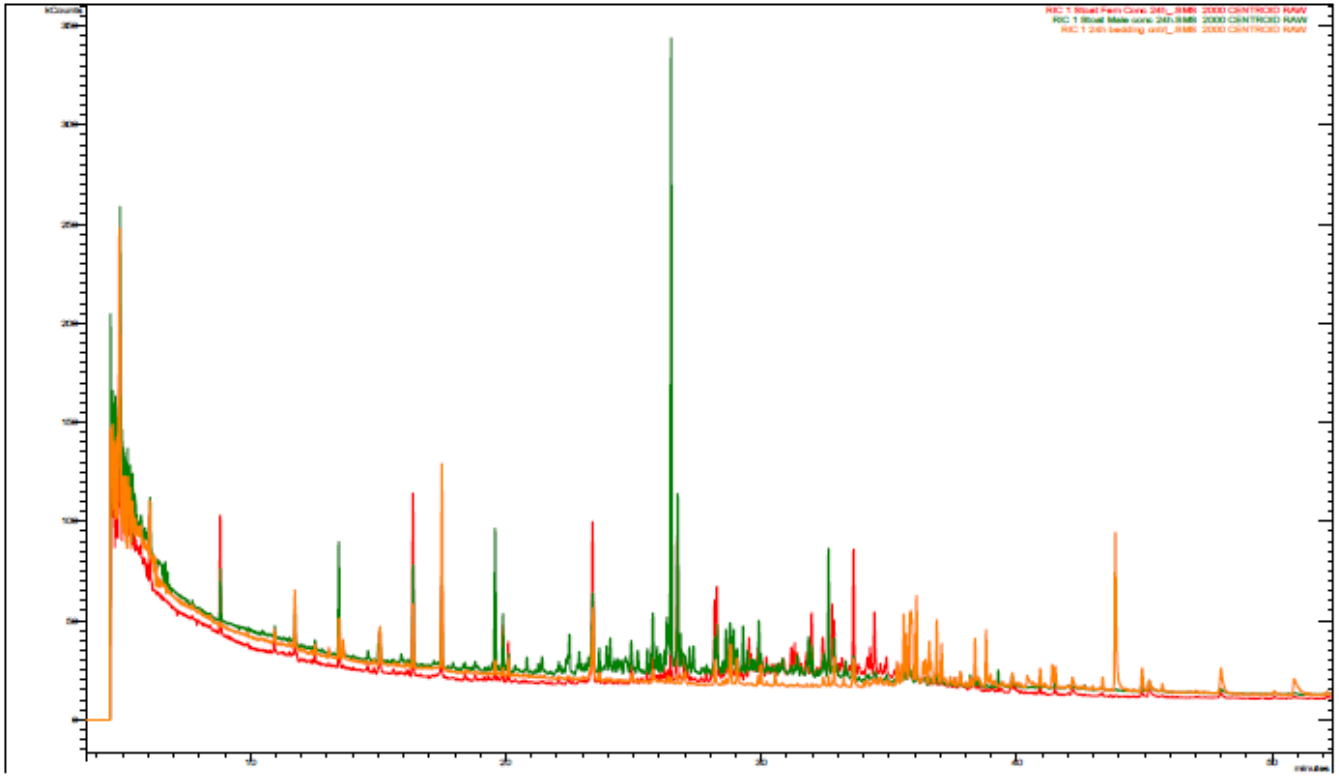
SaF

	Pass	Fail
Timms		✓
KBL tunnel		✓
Tunnel		✓
SaF		✓
Conibear 120		✓

Multi-Kill Traps

24 hr volatile collection from bedding – Andrew Twidle

Overlaid Chromatogram Plots



Red trace = Female bedding
Green trace = male bedding
Brown trace = control bedding