Karearehe Kino
Vertebrate Pest Research

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Manaaki Whenua
Landcare Research

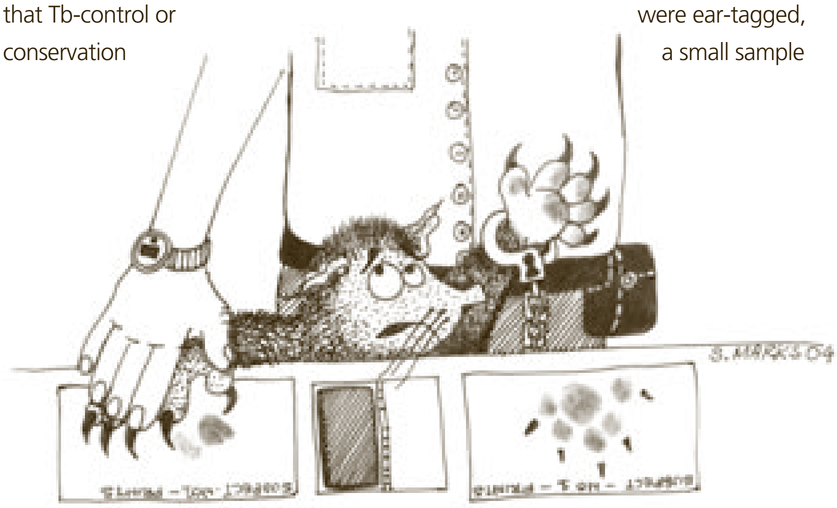
Using DNA Fingerprinting to Interpret Residual Trap Catch Indices

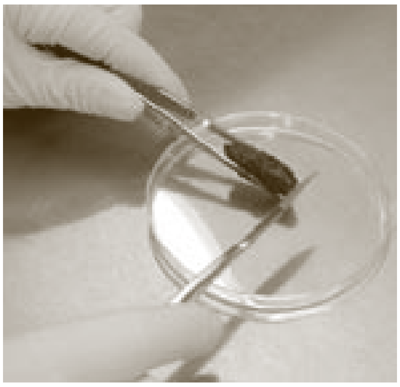
The effectiveness of possum control is presently assessed using the Residual Trap Catch Index (RTCI), in which the number of possums caught per trap night is compared with an operational target (usually between 1 and 5% catch rate). However, pest managers sometimes record low or zero RTCIs immediately following control but several months later find possums to be surprisingly abundant.

Graham Nugent and colleagues carried out trap-catch monitoring at intervals after control in three areas. Even allowing for immigration, the rate of increase of all three populations well exceeded the possum’s reproductive capability, confirming that the RTCI had underestimated each population immediately after control. Such a bias could result in pest managers believing that Tb-control or conservation objectives have been met, with contractors receiving payment for inadequate possum control.

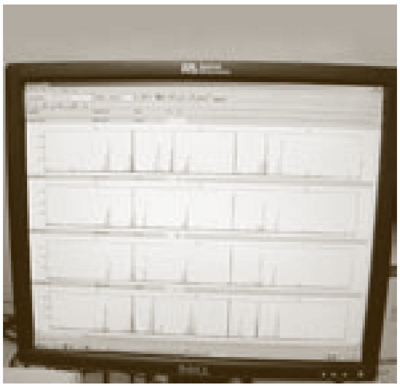
Determining the size of this bias, and the causes of it, are high priorities. DNA ‘fingerprinting’ possums from their faecal pellets is an innovative hi-tech way of identifying untrappable possums (see *Kararehe Kino 2*). Possums produce lots of pellets each night and scatter them widely, so all possums should be detectable. Dave Morgan, Graham Nugent and Dianne Gleeson are using the technique to assess whether possums that survive control are less trappable than average, and if so, whether their reduced trappability is temporary.

Dave and his team conducted a pre-control trapping survey in June 2004 near Haldane in Southland. Possums were ear-tagged, a small sample





DNA is obtained from possum faecal pellets by removing and chemically processing the surface layer of the pellet, which contains cells from the gut lining.



After analysis, unique DNA profiles from different possums can be identified. In the figure, the middle two rows represent samples from the same possum.

of ear tissue collected, and then the animals were released. Faecal pellets were collected throughout the area. The proportion of DNA fingerprints from trapped possums that matched DNA fingerprints from pellets was a direct measure of the trappability of the possums at that time, and was used to calculate real densities of possums. In August, control was carried out using prefed Feratox® bait (encapsulated cyanide), followed 3 weeks later by prefed cyanide paste. All bait points were logged using GPS to confirm thorough bait coverage. About 80% of the population was estimated to have been killed and an ear-tissue sample was taken to check for any previously untrapped possums. The trapping and faecal pellet surveys were repeated 1 month after control, and will be repeated 5 and 10 months after control, to compare the 'trappability' of the surviving possums over time.

As well as measuring changes in trappability, the researchers are investigating possible causes of these changes.

- Firstly, survival may occur if possums with small home ranges fail to encounter poison baits: these possums may also fail to encounter traps after control.
- Secondly, control may fail to target possums that spend most of their time in the canopy away from poison baits. Such animals may be identified from faecal DNA but are unlikely to be trapped. 'Litterfall' traps have been set up to collect faecal pellets from canopy-feeding possums. Any change in the proportion of survivors in the canopy may be revealed by changes in the ratio of pellets found in litterfall traps and on the ground beneath the traps (i.e. reflecting ground-level activity).
- Thirdly, little is known about the possible effects of control on the behaviour of surviving possums. In a nearby study site, Adrian Monks and colleagues have fitted possums with radiocollars, and the movements of survivors there will be compared with possum movements before control. It is possible that disruptions to social groupings may lead to more restricted movements and/or cautious behaviour immediately after control, and hence lower trappability. Conversely, over time such possums may extend their range in the absence of competitors, and increase their likelihood of encountering traps.
- Fourthly, possums that survive a sublethal dose of cyanide are known to develop a strong, long-lived aversion to cyanide baits. However, it is not known if this aversion extends to other 'unnatural' objects that appear in the possums' environment, including traps.

Overall, the research will provide a clearer understanding of the influences on trappability and the nature and size of the biases in RTCI. This will give managers and contractors more confidence when interpreting RTCI data and judging how effective possum control has actually been. Equally importantly, perhaps, the research will prove DNA fingerprinting to be a new (and increasingly affordable and straightforward) tool for providing unbiased estimates of actual possum numbers at extremely low densities.

This work was done under contract to the Animal Health Board.

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Graham Nugent, Dianne Gleeson (not shown)

1080 and Potential Risks to Soil Organisms

The vertebrate pesticide 1080 is scheduled for regulatory reassessment during 2004/05 under the Hazardous Substances and New Organisms Act (1996). Among other aspects, the reassessment will consider the ecotoxicity of 1080 to soil organisms. However, there are some obvious gaps in the information available on soil ecotoxicity and Kathryn O'Halloran and her team of ecotoxicologists have been generating 1080 toxicity data for earthworms, plants, and soil microbes.

Earthworms are commonly used as indicator species of contaminants in soil because of their importance in soil ecosystems. The species recommended for the testing of chemicals is the introduced compost worm, *Eisenia fetida* (photograph). It was not possible to conduct toxicity tests on New Zealand native earthworms because they are not available in sufficient numbers, and techniques for culturing and maintaining healthy populations of them in the laboratory have not been developed.

Kathryn's team exposed sexually mature compost worms to soil containing various concentrations of 1080. The cocoons the worms produced during the 28-day exposure period were allowed to hatch over a further 28 days. Although the compost worms lost weight over the first 14 days in soil concentrations

*Compost worms (*Eisenia fetida*).*

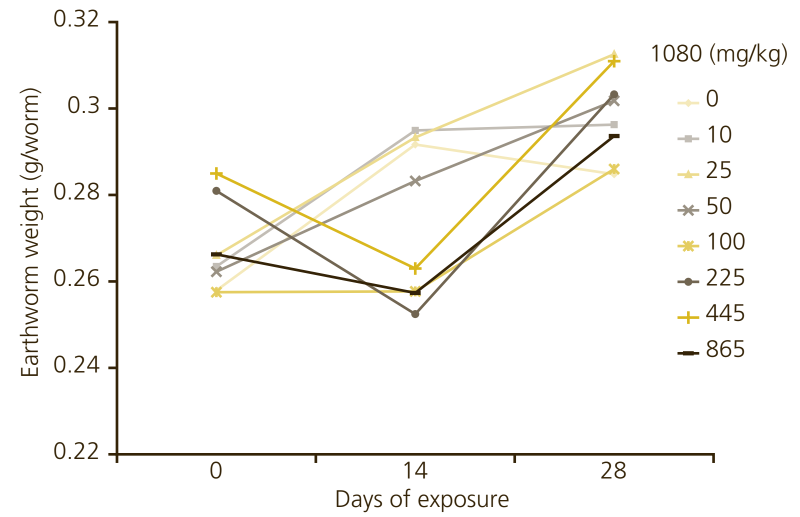

Fig. 1. *Compost worm weights over 28 days exposure to different concentrations of 1080.*

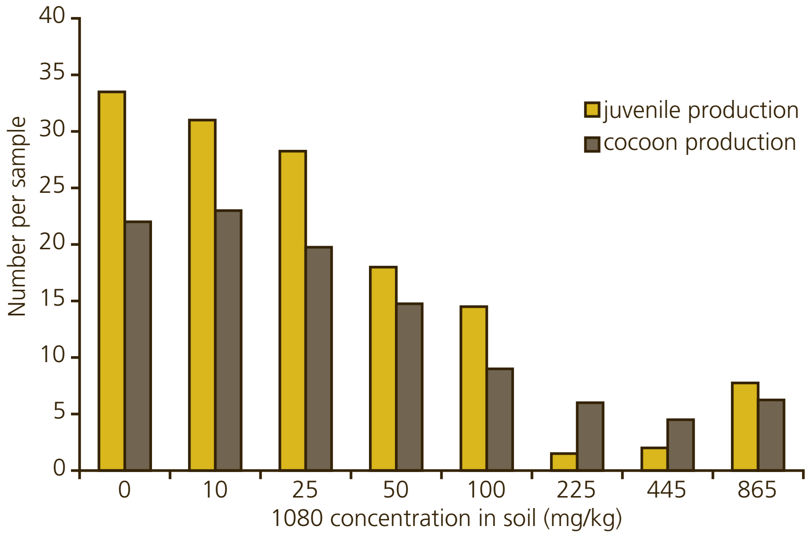

Fig. 2. *Compost worm fecundity following 28 days exposure to 1080.*

≥100 mg 1080/kg (Fig. 1), their weights had returned to normal by day 28. This indicates that after an initial acute response the energy resources in adult compost worms were being channelled into maintaining body weight. However, condition appeared to be maintained at the expense of reproduction, since cocoon production and the number of live juveniles produced decreased progressively as 1080 concentrations increased, particularly at concentrations ≥100 mg/kg (Fig. 2). Such levels are well above those that normally occur following the use of 1080; the predicted average soil concentration of 1080 due to leaching from possum baits was 0.015 mg/kg and the maximum 1080 residue ever recorded in a single field soil sample following bait application is 0.08 mg/kg.

Soil contaminants can also affect plant reproduction, for example by interfering with the processes of seedling emergence or seedling growth following uptake via the

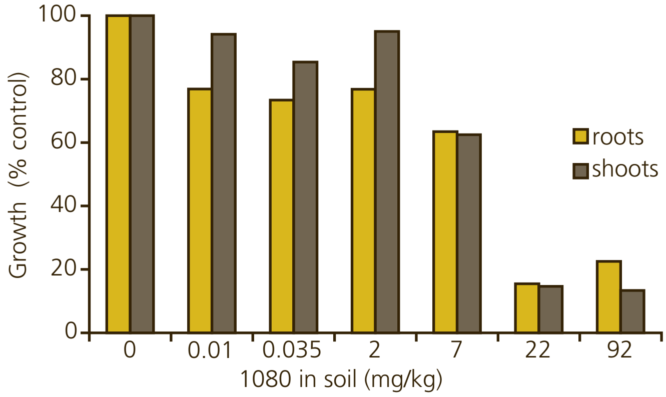

Fig. 3. *Effect of 1080 on lettuce seedling growth.*

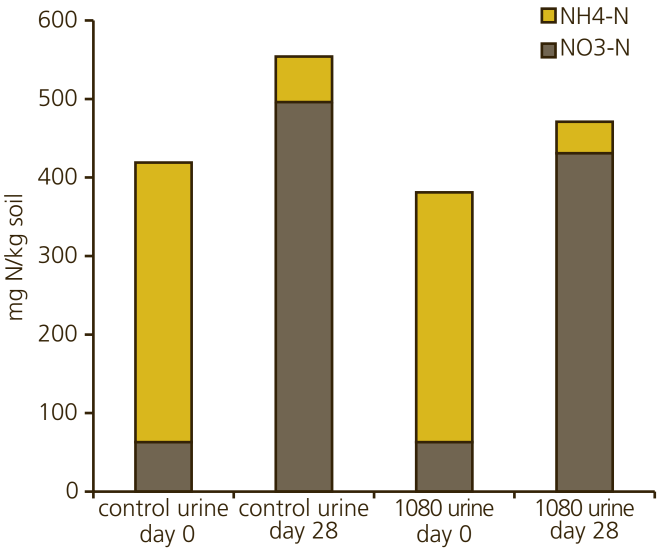

Fig. 4. *Nitrate mineralisation in soils contaminated with possum urine from 0 to 28 days. Urine was collected from the same possums prior to (control urine) and following 1080 bait ingestion (1080 urine).*

roots. As an example, 1080-induced impacts were evident on lettuce seedlings, but only at higher 1080 concentrations. Although germination was not significantly affected at soil 1080 concentrations below 92 mg/kg, lettuce seedlings took longer to germinate, with shoot growth following emergence decreasing significantly at concentrations at and above 7 mg 1080/kg (Fig. 3). Effects on oats were similar but less pronounced.

Microbes are pivotal in the breakdown and transformation of organic matter, contributing to the fertility and health of soil. Interference with these processes could potentially affect nutrient cycling and soil fertility. The mineralisation of nitrogen from organic material into a soluble form suitable for plant uptake is a critical step in the process of nutrient cycling. However, no 1080-related inhibition of soil microbial function occurred at any test concentration (up to 1000 mg/kg). In addition, urine collected from possums before and after ingesting a lethal dose of 1080 did not pose a potential hazard to soil fauna, as microbes in soil spiked with urine (whether or not from 1080-poisoned possums) were not impeded in their ability to convert urine-derived N (predominantly as NH^{4+}) to nitrate (NO^{3-}) (Fig. 4).

To establish ecotoxicological risk following 1080 exposure, Kathryn's team considered both the hazard posed by the pesticide and the likelihood of exposure. Because it is not possible to test all species in an ecosystem, ecotoxicity testing uses 'surrogate' test species to evaluate the hazard of a substance. The lowest adverse effect level observed in this series of tests (7 mg 1080/kg for lettuce seedling emergence and growth) was more than 100 times higher than the maximum soil concentration of 1080 measured following a normal 1080 bait operation (0.08 mg 1080/kg). The data collectively indicate that 1080-related effects on the soil organisms used in these regulatory tests occur at concentrations well above those encountered in the environment following the application of 1080 in baits for possum control.

This work was conducted as a series of projects contracted by the Animal Health Board and complements existing regulatory toxicological data for 1080 that underpins future regulatory assessment and control of 1080 in New Zealand.

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Denise Jones, Lynn Booth and Penny Fisher (not shown)

Taking the Community with You: a Process for Developing Acceptable Pest Control Strategies

Scientists are being told more and more that they must 'take the community with them', but how do they do that? To address this question, the Ministry of Research, Science and Technology set up a special fund in 2002 for research on ways of improving dialogue between scientists and communities.

Over the past year, Phil Lyver, Lynley Hayes and Chrys Horn organised four hui to test a novel dialogue process involving aspects of tikanga Māori combined with training in formal listening skills. Two hui focused on using 1080 to kill vertebrate pests (highly controversial), and two hui on the biological control of weeds (less controversial). The marae setting was chosen because it has traditionally been, and continues to be, the place where formal dialogue has occurred for Māori. It provides an environment where all viewpoints can be heard and considered. The programme suggests strategies for improving listening and understanding, and for tapping into the collective wisdom, imagination, and skills of diverse groups, to come up with new and better ways of doing things. Putting these two approaches to dialogue together seemed like a good idea.

Those attending the two 1080 hui represented tangata whenua, Department of Conservation, Regional Councils, Animal Health Board, New Zealand Deerstalkers Association, Environmental Risk Management Authority, Federated Farmers, Landcare Research, Forest and Bird Protection Society, District Councils, Youth, The Game and Forest Foundation, Target Pest Enterprises (ECan), and New Zealand Pig Hunters. After the formal welcome on the first day, everyone was given the opportunity to present their perspectives on 1080 use. Participants could ask presenters questions of clarification, but could not challenge individual viewpoints. Meals shared on the marae, social events in the evening, and sleeping-over in the wharenui helped break down barriers and gave people the opportunity to learn more about each other and Māori culture and history, as well as informally discuss the 1080 issue.

Stakeholders attending a dialogue hui at Matahiwi Marae, Hastings.

On the second day, the participants focused on the processes of effective listening. People with opposing viewpoints arising from the earlier discussions were paired up and given an hour to prepare and present the other person's viewpoint back to the wider group. Listening this way often meant gaining a greater understanding of why those with differing views held them, and sometimes led to a shift in personal viewpoint. Also, giving people the opportunity to hear things twice helped to cement both learning and understanding. By lunchtime, all people had a much better grasp of the viewpoints surrounding the use of 1080 and were more able to work together to come up with potential solutions or alternatives to 1080. Even ideas that were only partially developed still contributed to future thinking.

So what did the participants learn from this process and how did it help the scientists understand the concept of 'taking the community with them'? Clearly, the process helped people with differing views to discover what values they had in common, even those involved in the controversial

1080 debate. Many participants found to their surprise that the scientists in the group shared many of the same values that they had, and were just as passionate about New Zealand's natural environment. This recognition facilitated a trust that rarely arises when groups are bombarded with facts about how safe some controversial scientific and management techniques are.

Another useful outcome was that participants were able to weigh up the pros and cons of using such pest control technologies in an environment where those in authority could not revert to persuasion as a means of achieving support. In some situations, scientists and managers try to defend approaches to past pest control. People who become disillusioned with traditional methods of consultation in which they are asked for input so late in the process that it becomes a 'box-ticking' exercise with little opportunity for meaningful dialogue. People need to be listened to earlier rather than later. The difference between being consulted on how to control possums locally and being asked to give approval to drop 1080 is considerable.

The dialogue team will be working to further develop and fine-tune this process in 2004/05. Challenges will be to find ways of involving stakeholders who are reluctant or less able to take part, to test the process out in other environments, and work towards achieving resolution on particular issues. Another challenge will be to encourage more scientists to adopt and use this process.

The team would like to thank all the people who gave up their time to participate in these hui and the people at Tuahiwi, Takahanga, Wairaka and Matahiwi for generously hosting the events.

This project was funded by the Ministry for Research, Science and Technology.

Other reading: Covey, S.R. 1989: *The seven habits of highly effective people: restoring the character ethic*. New York, Simon and Schuster.

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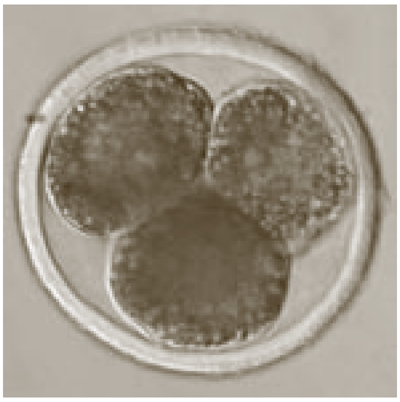
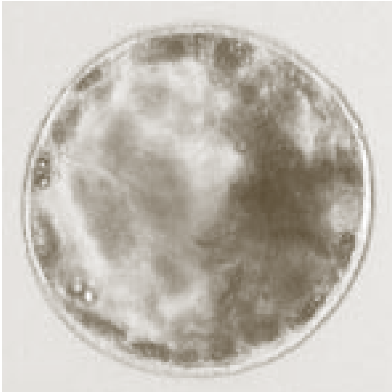
Lynley Hayes, Chrys Horn (not shown)

Progress towards Stoat Fertility Control

New methods for manipulating reproduction of stoats in captivity will speed development of new techniques to control wild stoats. Stoats are one of New Zealand's most destructive predators, responsible for the decline of several native iconic bird species. Current control techniques, like labour-intensive trapping and ground-based non-specific poisoning, are inadequate and raise serious concerns about non-target impacts, humaneness, and environmental risk. Fertility control is one approach being developed as a sustainable and potentially species-specific method of stoat control that could be used over large areas with enhanced acceptability and safety. In combination with current methods, it would also offer a cost-effective solution for managing stoat overabundance in the long term.

Stoats have an unusual breeding system that lends itself to disruption at various stages. These include egg development and fertilisation in spring, 9–10 months of arrested embryonic development (diapause), and a 4-week period of implantation prior to birth of multiple young the following spring. Susana La Falci and Frank Molinia are developing reproductive technologies for stoats to efficiently evaluate various 'agents' (e.g. chemicals, proteins, peptides, and other antigens) for their ability to disrupt these key reproductive stages and hence prioritise those suitable for stoat fertility control. This work builds on the success of similar approaches used in possums (see Possum Research News 17), where techniques such as hormone treatment and artificial insemination are now routinely used to screen fertility control vaccines for possum biological control. The challenge is to tailor these approaches for monitoring and manipulating stoat reproduction in captivity.

The team has developed methods for

Stoat embryos at different stages of development during in vitro culture: (left) 4-cell embryo 24 hours in culture; (right) early blastocyst after 96 hours in culture.

liquid- and frozen-storage of stoat sperm, and a non-surgical technique for depositing sperm in the female stoat reproductive tract – the first time anyone has been able to do this successfully. These are key steps towards the development of artificial insemination (AI) technology. The advantage of this approach is that it could improve captive breeding success and potentially circumvents the need to keep males in captivity. The remaining challenge is to develop a method for inducing egg release (ovulation) in stoats, which normally follows the act of mating. Future efforts will focus on using vasectomised males or hormone treatment to induce ovulation. Once established, AI will not only offer a cheaper and more reliable alternative to captive mating of stoats to achieve pregnancy, but promises to be an efficient tool to test fertility control agents for their ability to disrupt egg development and fertilisation.

Susana has also developed a method for assessing the quality of developing stoat embryos, another first for stoat research. Early-stage embryos were recovered from naturally mated females and found to successfully develop into fluid-filled balls of about 250 cells (blastocysts) in laboratory culture. Already this technique has been used to evaluate techniques for enhancing stoat reproduction. Using a protocol that was successful for possums, female stoats were hormone-treated prior to natural mating in an attempt to improve embryo yields. The numbers of embryos produced and their capacity to develop in culture was not different between untreated and hormone-treated stoats after natural mating. Embryo culture will also be important for evaluating the success of AI technology and a cost-effective alternative to whole-animal trials for testing fertility control agents targeting early embryo development.

One of the most exciting and cutting-edge techniques under development by Susana and her team is non-invasive monitoring of stoat hormones. Current research is focusing on measuring testosterone to monitor male reproductive function, oestradiol to monitor female reproductive cycles, and progesterone to monitor pregnancy, using hormone metabolites in faeces. This approach is far superior to collecting multiple blood samples, which is not feasible in stoats and likely to produce abnormal hormone profiles due to the stress of handling and anaesthetising the animals. After optimising an extraction procedure, the types of reproductive hormone metabolites present in stoat faeces were determined. Appropriate laboratory assays have now been designed to measure these hormone metabolites and are currently being used to monitor male and female reproductive function.

Once these new techniques are in routine use, they will help us better monitor captive breeding and manipulation of stoat reproduction. If hormone monitoring can successfully detect reproductively functioning males, and distinguish between cycling and non-cycling and pregnant and non-pregnant females, then the team will have a valuable tool to add to the protocols for testing fertility controls targeting any aspect of stoat reproductive function.

This research was funded by the Department of Conservation.

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Frank Molinia (not shown)

Could a Pig-Ferret Co-scavenging Cycle Sustain Tb?

In New Zealand, possums are the only wildlife species with readily self-sustaining bovine Tb infections and they are the primary source of Tb in livestock. In contrast, pigs, ferrets, and deer are regarded as 'spillover hosts' that become infected mainly from possums. Ferrets and deer can become maintenance hosts when their densities are very high, but such high densities seldom occur in wild populations in New Zealand. In general, Tb prevalence in these spillover hosts is high only where Tb is common in possums.

An apparent exception to this pattern is found in the semi-arid northern South Island high country. There, possum habitat is patchy and possum densities overall are low, yet high levels of Tb occur in ferrets and pigs. Recent evidence from Spain indicates pig-to-pig transmission of Tb, and ferret-to-ferret transmission has been inferred in New Zealand. Could some cycling of Tb that is independent of possums explain the apparently unusual epidemiological patterns recorded in this type of country?

As both pigs and ferrets are believed to become infected mainly through scavenging carrion, the most likely mechanisms for possum-independent transmission in these species seems to be either cannibalism or co-scavenging. To test these possibilities, Andrea Byrom, Ivor Yockney, and Graham Nugent investigated how often ferrets scavenge ferret and pig carcasses, how often pigs scavenge ferret and pig carcasses, and whether such scavenging occurred frequently enough to enable Tb to persist within either species alone (via cannibalism) or in both species via pig-ferret co-scavenging.

The fate of whole ferret carcasses and of whole and part carcasses of pigs were monitored using motion-activated video cameras to determine how many different species scavenged or interacted with

Table. *Percentages of pig and ferret carcasses scavenged by six wildlife species.*

Species	Season	Pig remains scavenged (%)	Ferret remains scavenged (%)
Australasian harrier	Summer	69	100
	Winter	100	100
Ferret	Summer	77	80
	Winter	n.v.[1]	0
Feral cat	Summer	62	75
	Winter	50	0
Possum	Summer	0	0
	Winter	20	0
Hedgehog	Summer	23	25
	Winter	n.v.	20
Pig	Summer	8	n.v.
	Winter	0	n.v.

[1]No visits recorded

them. The team was also interested in how Australasian harriers, cats, hedgehogs, possums, and cattle reacted to carcasses, as any close interaction had the potential to contribute to the cycle of infection in wildlife. Fifty-six carcass sites (33 ferret and 23 pig) were monitored for a total of more than 380 video-days.

As well as millions of flies and several species of small birds, 10 different vertebrate species were recorded near the carcasses, but rabbits, hares, small birds, sheep and Paradise ducks did not interact with carcasses at all. Cattle sniffed and even licked both pig and ferret carcasses on a couple of occasions and so could conceivably become infected with Tb from that.

Six vertebrate species fed on carcasses at different frequencies and to differing extents (Table). Harriers were the most common scavenger. They fed on most pig carcasses, but only when they had been 'opened up' by other species (or hunters). Harriers were able to open up ferret carcasses by themselves and did so on numerous occasions. A potentially important observation was the messy way in which harriers fed, tugging at the flesh, flicking pieces widely, and trampling over the carcass, making it likely that pus from any Tb lesion present was spread over the surface of the carcass, and encountered by the next scavenger or by cattle.

Ferrets fed on most whole and part pig remains in summer but not in winter. Families of up to six ferrets fed on a single pig, returning again and again until most edible tissue had been eaten. Transmission from heavily infected pigs to ferrets therefore seems likely. Ferrets also cannibalised other ferrets, confirming that ferret-to-ferret transmission is likely. In contrast, very few pigs visited either pig or ferret carcasses, and the few interactions recorded were brief, indicating that the hypothesised pig-ferret co-scavenging cycle was probably not important in the northern South Island.

Possum feeding on mesenteric tissue and fat from a pig gut pile.

Possums visited five pig carcasses and fed briefly on two of them (see photo). Possums didn't feed on ferret carcasses although they did sniff and lick carcasses opened up by harriers and feral cats. While the frequency and duration of these interactions was probably far too low to be important in sustaining Tb in possum populations, it may well be an important mechanism for spreading Tb geographically. Both pigs and ferrets are more wide-ranging than possums, and may be more likely to transport the disease to new locations, where the kinds of interactions observed could then result in the transmission of Tb to new previously uninfected possum populations.

Overall, the team's observations indicate scavenging by possums may play a role in Tb spread, while cannibalism and co-scavenging appears likely to extend Tb persistence in ferret populations but not in pigs.

This work was contracted by the Animal Health Board and the Foundation for Research, Science and Technology.

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Ivor Yockney, Graham Nugent (not shown)

Tb and Leptospirosis: Are They Sexually Transmitted Diseases in Possums?

Brushtail possums are the main wildlife vector of bovine Tb in New Zealand, and infected possums are primarily responsible for ongoing infections in livestock and other wildlife. Tb in possums is transmitted mainly by close contact between susceptible and infected possums through behaviours such as sharing dens, fighting, and mating, with contacts associated with mating thought to provide particularly important avenues for such disease transmission.

If contacts associated with mating are shown to be important routes for disease transmission, then this could have implications for the control of Tb and some other diseases. The reason for this is that the frequency of mating contacts in higher animal species generally does not decrease in proportion to reduced population density. In possums, there is some evidence that when population density is reduced males maintain their contact rate with females by enlarging their home range size.

Diseases where the contact rate is largely independent of population density are termed 'frequency dependent', and include human diseases such as HIV, which is transmitted largely by sexual contacts. Diseases where transmission is largely dependent on population density are termed 'density dependent', and include such human diseases as measles and rubella. Frequency-dependent diseases are typically harder to control than density-dependent diseases as they can be maintained even at low population densities, making eradication difficult. However, before investigating the frequency of mating contacts in possums, the importance of such contacts in the transmission of Tb in possums needed to be investigated.

Dave Ramsey and Jim Coleman undertook an experiment to determine the contribution of contacts associated with mating behaviour to the transmission rate of two diseases dependent on social contact in possums, *Mycobacterium bovis* (Tb) and *Leptospira interrogans* serovar *balcanica* (*L. balcanica; Leptospirosis*). They did this by experimentally manipulating mating behaviour in individual possums and comparing the transmission rate of the disease (force of infection) between manipulated and unmanipulated possums. Mating behaviour was manipulated by surgically removing the gonads (gonadectomy) in individual possums (testes in males; ovaries in females). Gonadectomy effectively blocks or drastically reduces the production of sex-steroid hormones (testosterone; oestrogens), resulting in either the complete or partial disruption of mating behaviour. Since sex hormones also play a role in determining dominance hierarchies in animal populations, blocking sex hormone production should also lead to reduced aggressive interactions between possums, especially males, as has been demonstrated in most domestic animals.

Altering mating behaviour by gonadectomy resulted in an 88% decrease in the force of infection of *L. balcanica* and a 53% decrease in the force of infection of *M. bovis* in male possums (Figs 1 and 2). However, gonadectomy had an ambiguous effect on female possums, with a 63% decrease in the force of infection of *L. balcanica* but a 3-fold increase in the force of infection of *M. bovis*. The reasons for the increase

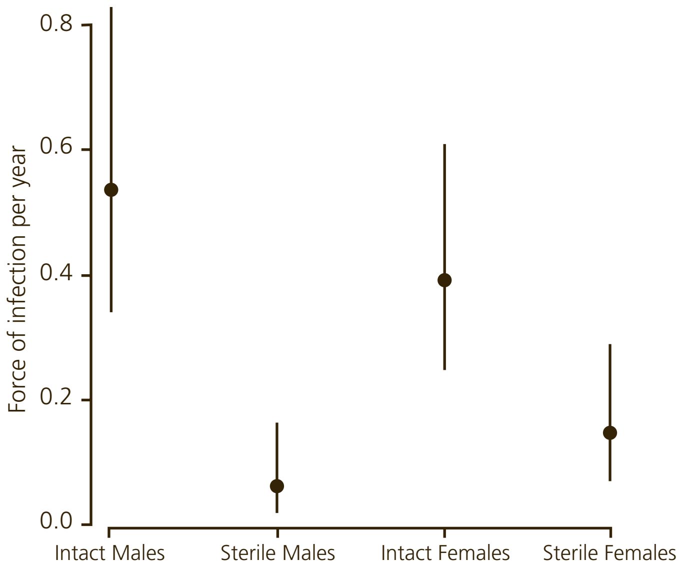

Fig. 1. *Estimates of the force of infection (± standard error) of* L. balcanica *in intact and sterilised male and female possums.*

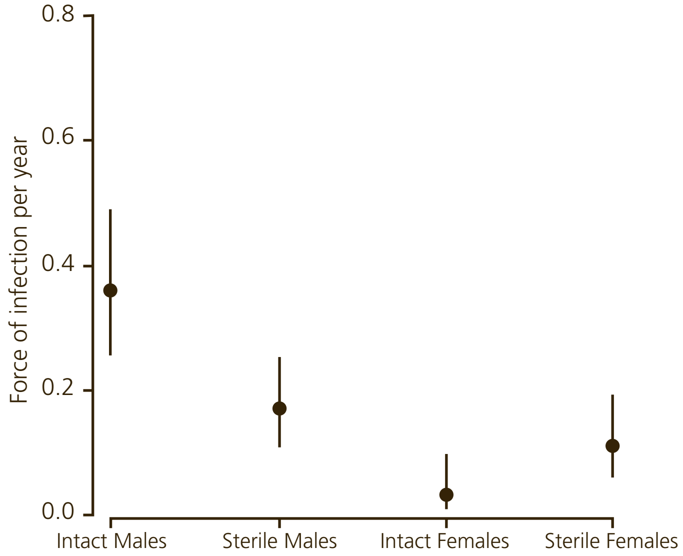

***Fig. 2.** Estimates of the force of infection (± standard error) of* M. bovis *in intact and sterilised male and female possums.*

in the transmission rate of Tb in gonadectomised female possums are unclear. Statistically, the effect was weak so it could be a sampling artefact. However, there remains the possibility that removing the gonads of female possums increased their susceptibility to Tb infection. Among most higher animal species, males are generally more susceptible to protozoan, fungal, bacterial, and viral infections than females, and field and laboratory studies have linked increased susceptibility to disease with circulating sex-steroid hormone concentrations. These studies have shown that androgens in males and oestrogens in females lower and enhance immunity respectively, with gonadectomised males having greater resistance to infection and gonadectomised females having reduced resistance.

Whatever role sex-steroid hormones may play in disease susceptibility, Dave and Jim's experiments showed that, at least for male possums, the transmission of diseases requiring close contact, such as Tb, seems to be linked to sex steroid hormone levels. The much greater force of infection of Tb in males compared with females strongly suggests that the dynamics of Tb are driven largely by males. Hence, methods of fertility control being developed for possums that also disrupt sex-steroid hormones could have additional benefits for the control of Tb by reducing the transmission rate of disease among males. Further work is needed to clarify whether the reduction in the transmission rate is due primarily to changes in the sexual contact rates or changes in susceptibility to infection.

This work was funded by the Foundation for Research, Science and Technology.

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Distinguishing Primary and Secondary Prey Is Important for Conserving Endangered Species

There is often confusion over whether a prey species is 'primary' or 'secondary' for a predator. To get things into a clearer perspective, primary prey are those that are preferred by a particular predator and that support that predator's populations. This means that a decline in such prey will result in a decline in the predator population, although usually after a delay. Secondary prey species are those that are eaten by predators as alternative foods when primary prey decline, or incidentally when a predator stumbles across them. The predator thus does not depend on this prey species for its well being (when primary prey are present) and so, having access to other prey, can drive the secondary prey population to extinction without affecting its own population size.

A classic example of this type of interaction is seen in the complex of foxes, rabbits and endangered marsupial prey in West Australia. There, foxes live at high density on farmland, feeding on rabbits and carrion from livestock but also going into the surrounding woodland and catching marsupials living there, sometimes driving them to extinction. This dynamic was first demonstrated in the 1980s in a fox removal experiment at Dryandra. When foxes were kept at low numbers in the woodland through persistent 1080 poisoning, the numbers of endangered brush-tailed bettong rebounded to high levels. This experiment was repeated at a number of sites with the same results for numbats, quolls, bandicoots and black-footed rock-wallabies. In New Zealand similar results have been obtained with the endemic kōkako, which suffer severe nest predation from rats and possums, and a few adults are also killed by stoats (Fig). John Innes and colleagues from DOC (Ian Flux and Phil Bradfield) conducted a long-term removal experiment of all three predators at Mapara that allowed the kōkako population to increase. Both possums and ship rats are dependent on other food sources, but together they can exterminate the kōkako if allowed to exist at normal high densities.

The general understanding of such predator–prey dynamics has been investigated by Tony Sinclair (Landcare Research 2003/04 Hayward Research Fellow) for many years. Tony believes that a decline in primary prey populations has two consequences for predator populations. Firstly, predators switch to eating secondary prey because of a lack of anything else to eat, and as a result cause increased mortality in non-traditional (secondary) prey populations. However, by definition, such secondary prey species are inferior for the needs of predators, so the higher level of predation is always temporary. That is to say, a change in the behavioural or functional response of the predator to a suite of primary and secondary prey populations lasts a relatively short time. The implication for managers is that if predator numbers can be reduced during this transition period, then the pulse of predation on the secondary prey can be avoided.

Secondly, the poorer food supply results in delayed compensatory numerical responses in the predator population. Changes are likely to include lower reproduction, higher mortality, and higher dispersal eventually leading to a numerical decline in the predator population. This should in turn result in lower predation rates on the secondary prey.

Despite these well-known predictions, there is almost no evidence demonstrating functional and numerical responses when primary prey are removed. Both predictions have important conservation consequences, particularly in New Zealand where so many of the prey species are endangered. Tony suggests it would be appropriate to set up an experiment designed to test

Photo: R. Colbourne

Kōkako

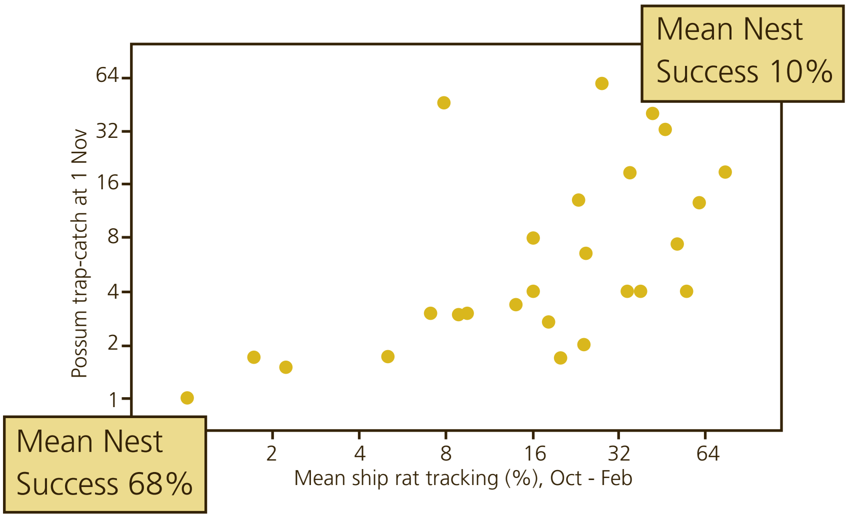

Fig. *Abundance indices of possums (captures per 100 trap-nights) versus rats (% tracking tunnels with tracks) from many years and sites of North Island kōkako management, with kōkako nest success when (a) both possums and ship rats have 'high' abundance (top right), and (b) 'low' abundance (lower left). J. Innes (Landcare Research), I. Flux (Department of Conservation, unpub.data). Both ship rats and possums must be controlled to increase kōkako populations.*

both predictions. The experiment should compare areas where primary prey species are removed with those where they are untouched, in three phases: before removal, during a transient functional-response phase, and during a numerical-response phase. The responses to be measured are (a) the diet of predators, and (b) the density of predators. An additional component to the experiment would involve predator removal during the transient phase to compare predation rates on secondary prey with that in an area where the predator press is not applied.

Dryland sites with ferrets and rabbits may provide the easiest logistics for such an experiment, but the stoat and rodent/exotic passerine complex should also be explored.

In summary, Tony suggests that for many New Zealand predator–prey complexes, there is already some information on the various components of these processes and a start should be made to assess what knowledge exists, what relevant knowledge is lacking, and whether there are conflicting results that need to be resolved. Once the knowledge gaps are identified, the process of planning the experiment can begin, including checking that measurements are appropriate to test the fundamental predictions underpinning such complexes. Testing such predictions will further develop the general understanding of predator–prey relationships and, more importantly for New Zealand, help local conservation managers in their attempts to conserve rare and endangered native biota.

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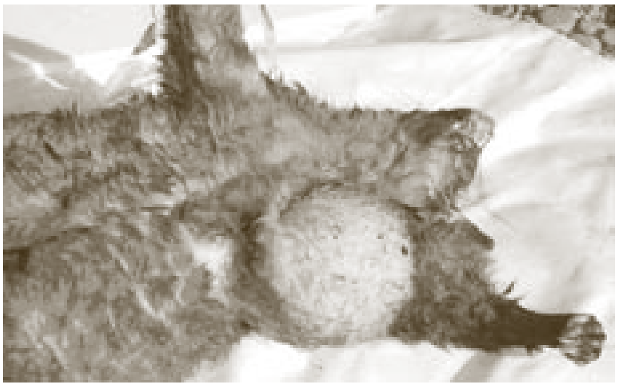
Possums Come in All Shapes and Sizes!

A recent sample of possums from Omoto, west of Lake Brunner, produced two unique individuals at necropsy. One defied all normal rules of anatomy while the other defied normal disease pathology. In the first case, a mature healthy male was found to possess two scroti with a seemingly normally functioning testis in each one (photo). The animal was in good condition and, apart from this abnormality, all its internal and external reproductive structures and associated plumbing appeared to be normal. Such an anatomical change to normal morphology has obvious protection value and could conceivably enhance reproductive fitness – a consequence of not having all your eggs in one basket!

Our second oddity had a truly exceptional lesion indicative of Tb (and later confirmed to be so) in its deep axillary lymph node (photo). Tb lesions in external lymph nodes normally progress as internal lesion pressures increase, from enlarged bodies filled with caseous ('cheesy') material, through a 'pointing' stage (by developing a 'head' as in the case of a boil), before erupting and draining its now more liquid contents to the exterior and returning to a more normal size. Draining generally

A possum uniquely endowed with two scroti.



A possum with an exceptional Tb lesion in its axilla.

occurs when lesions are about one-quarter the size of the current example. In this case, the lesion weighed 500 g but showed no sign of pointing or draining, despite clearly being dragged along as the animal walked. The contents of the lesion were caseous and the animals' lungs grossly consolidated by the infection, but despite this, the possum appeared to be in average physical condition. The equivalent in an 80-kg human would be a lesion weighing 13 kg hanging from the armpit – a huge inconvenience and a monumental source of infection!

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Conference

13th Australasian Vertebrate Pest Conference

Monday 2 – Friday 6th May 2005
Museum of New Zealand, Te Papa Tongarewa, Wellington, New Zealand
Nau mai, Haere mai

The Vertebrate Pest Committee (VPC) represents government agencies in Australia and New Zealand that have responsibilities for vertebrate pest management. Every three or four years the VPC holds a conference of submitted oral and poster papers on research, policy and management of vertebrate pests. The next conference is to be held in New Zealand in May 2005.

Papers are invited for either oral or poster presentation. Contributed oral papers are 20 minutes in length and are presented either within symposia on themes selected by the VPC or in general sessions.

Symposia in 2005 include:

1. Management of bird pests
2. Management of freshwater fish pests
3. Surveillance, detection and search theory for new invasions and eradication of pests and their diseases
4. Threat abatement plans and national control plans for critical pest species
5. Diseases of vertebrate pests

Call for papers and posters:

Authors wishing to present papers or posters are required to submit abstracts.

- No more than 400 words
- Deadline 31 December 2004

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All papers and posters will be published in a conference proceedings and available at the conference.

Registration and Accomodation details are now available at http://www.landcareresearch.co.nz/news/conferences/vertbratepest/

Conference sponsored by

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A Selection of Recent Vertebrate Pest-Related Publications

Booth, L. H.; Fisher, P.; Heppelthwaite, V.; Eason, C. T. 2004: Risk of FeraCol baits to non-target invertebrates, native skinks, and weka. *Science for Conservation* 239. Wellington, Department of Conservation. 18 p.

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- **Focus** - Land Environments of New Zealand (LENZ) Project Progress Reports
- **He Kōrero Kōrari** - covers work in partnership with Māori weavers on the effect of environmental conditions on the leaf and fibre qualities of traditional weaving varieties of harakeke (flax).
- **Kararehe Kino / Vertebrate Pest Research** - is a revamped Landcare Research newsletter that expands the focus of the old *He Kōrero Paihama – Possum Research News* to cover all our research on vertebrate pests.
- **Information In Formation** - spatial information work by Landcare Research.
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