# He Kōrero Paihama
# Possum Research News

*Issue 11* *May 1999*


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Manaaki Whenua
Landcare Research


## Pigeons versus Possums: 7-0 at Motatau

Landcare Research has been involved over the last three years in a cooperative project that is restoring the kūkupa (native pigeon) population at Motatau in Northland. Motatau Forest is a 350-ha remnant of taraire-kohekohe forest particularly important to the local Ngātihine, who, led by kaumatua Kevin Prime, have been co-managing the area with DoC since 1994. Since 1995, and in collaboration with John Innes and Graham Nugent, the project has been monitoring changes in pest abundance, kūkupa abundance and nesting success, and forest health. Kevin's vision – semi-serious – is to restore kūkupa to such abundance that they are declared orchard pests by 2010!

To date, the project has gone through three phases:

- *Prior to pest control* – August 1996 to September 1997: trap-catch indices of 26% for possums, tunnel-tracking indices of 17–45% for ship rats;
- *Pest control* – October 1997 to August 1998: possum control undertaken using bait stations, and progressively extended to surrounding properties to reduce immigration (indices of 7–11% for possums and 0–3% for ship rats);
- *After pest control* – September 1998 onwards : both possum and ship rat indices < 3%.

The outcome of kūkupa nesting attempts was starkly different between the phases. In the pre-control phase, of the 13 nests found with eggs, none

*Kūkupa (native pigeon) sitting in a kōwhai tree.*

lasted more than 10 days. All failed before hatching, mainly because of predation by possums. The team filmed possum predation at three nests, and predation by a ship rat of an unattended egg in another nest.

In the middle of the pest-control phase, when there were few ship rats but moderate numbers of possums, eight nests were found. Of these, four hatched chicks and one fledged a chick after intensive additional trapping around the nest. The other four nests failed either from predation or were abandoned. This year, with very low levels of possums and rats, the results are very different – seven out of seven nests have fledged chicks, with no extra protection at the nest trees.

Combining these results with similar data for kōkako (the only other large open-nesting bird for which we have comparable data, Fig. 1) gives a daunting "dose-response" curve. It suggests that birds such as these can only achieve 50% nesting success or better when ship rat and possum indices are below 5%. Where maximum breeding success is needed to kickstart a population recovery, the graph suggests possum indices shouldn't exceed 1%. Sadly, the decline in nesting success is very rapid with even small increases in possum and rat indices above this very low threshold, suggesting that, for these birds, pest control has to be done extremely well to have any benefit at all.

*Kōkako adults feeding fruits to chicks in the nest.*

Another striking benefit of possum control at Motatau has been the speedy recovery in canopy condition of some forest species. Foliar cover indices for kohekohe have leapt from 17% to 51%, and for the mamaku tree fern from 41% to 69% in just one year. The success of this cooperative research and management programme has provided an example that other iwi seek to follow, and has resulted in the increased involvement of local farmers, forestry companies, and the Northland Regional Council as informal partners in the pest control programme.

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

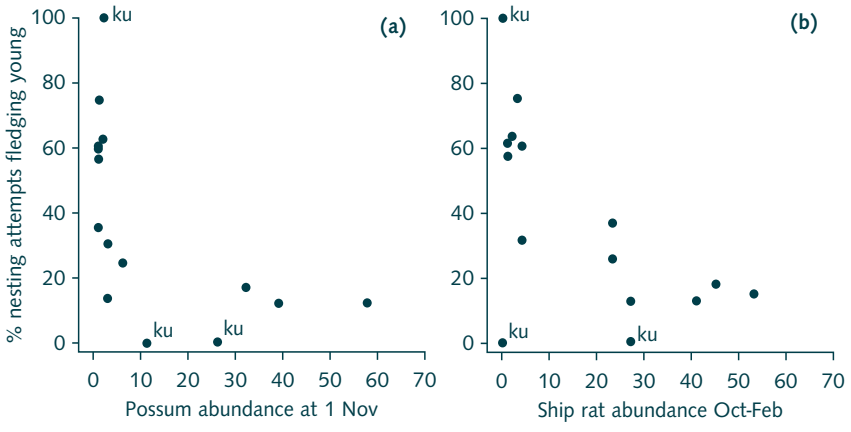



*Fig. 1. Nest success of kōkako from Mapara and Rotoehu (1989–1997), and of kūkupa (ku) from Motatau (1996–98), in relation to abundance of (a) possums (captures per 100 trap-nights on raised sets) and (b) ship rats (percent of baited tunnels tracked after 1 night).*

***Kevin Prime*** *is the Environmental co-ordinator for Te Rūnanga o Ngātihine and is on the Board of Landcare Research.*

***Graham Nugent*** *is in the Pest Impacts and Management team of Landcare Research based at Lincoln.*
***John Innes*** *is in the Ecosystems North team of Landcare Research based at Hamilton.*

# Guest Editorial

My experience in possum control spans back only to local government reorganisation in 1989, and I am amazed at how many significant changes have occurred within the possum control business over the last 10 years. The impetus for many of these changes has been the Pest Summits of 1993 and 1995. One of the outcomes of the first Summit was the formation of the National Possum Control Agencies (NPCA) in 1993, and this organisation has developed into the coordinating body for many aspects of the possum control industry.

I believe the NPCA is at a crossroads now – does it take the next logical step and become an information broker, a training coordinator and Quality Assurance auditor? Alternatively, do NPCA members decide the role of the NPCA has been fulfilled, and wind it up to leave respective agencies to pick up the tasks?

New Zealand is now targeting much more focussed outcomes for possum control – clear objectives have been identified such as reduced numbers of Tb reactors, increasing fledging rates in kōkako and kererū, vegetation coverage and survival of rātā and pōhutukawa, and zero leader damage in pine plantations. In the past, nebulous objectives led to poorly thought through initiatives such as bounty schemes, work schemes, and possum liberations all over New Zealand.

Now that we are more focussed, what are the issues to be addressed? The most pressing issue, I believe, is for the pest control industry to embrace and embody the NPCA Quality Assurance Scheme. The industry identified this as a top priority in June 1997 and gave a very clear mandate to the NPCA to coordinate the development of the scheme. Thanks to the efforts of Peter O'Connor, Project Manager, and the many industry people who have assisted him, the NPCA is about to launch the scheme.

The second issue is the future of the NPCA. To do the work needed, additional funding is needed. All the stakeholders must contribute at a level proportionate to their benefit. This includes the Government representing NZ Inc. – not just the Department of Conservation and the Animal Health Board. I have suggested that the NPCA and National Science Strategy Committee (Possums and Tb) combine to provide better integration of research and management operations. Most people appreciate the need for policy development, and will lobby for changes to legislation, funding, and inter-agency liaison. Technology transfer, training, and an information brokerage role are three very pragmatic tasks that the NPCA has demonstrated an ability to undertake. I would like investment in this direction to increase, and have suggested to the Foundation for Research, Science, and Technology, that the NPCA manage technology transfer funds in the relevant research areas. The Internet is seen as the logical platform to conduct the information brokering business, and the NPCA is committed to making this investment.

Thirdly, an important issue which faces all involved in pest management, is the medium term ability of researchers to develop biological control options for possums to a stage of field application. My concern is that unless the public of New Zealand is informed and convinced that immunocontraceptive vaccines are safe and necessary control methods, we may end up in a situation where the research application is completely frustrated. All agencies involved in possum control have a stake in ensuring biological control options remain viable, and sympathetically received by the public.

Lastly, I wish to acknowledge the immense amount of goodwill which exists between agencies, researchers, contractors, politicians and others with a very clear resolve to deal to the possum problem in New Zealand.

***John Simmons*** *is the chairperson of the National Possum Control Agencies, a member of the National Science Strategy Committee and the manager of Environment Waikato Biosecurity Group.*

# Pigs Provide Clues to the Biological Control of Possums


Immunocontraceptive vaccines to make possums infertile are being developed by scientists at Landcare Research, Lincoln. This work involves tricking the possum's immune system into producing antibodies that interfere with reproduction so that fewer females produce young. This new method of possum control has the advantage of being more socially and environmentally acceptable than traditional toxic control. It will reduce the risk to non-target species through the species-specificity of the control agent, and decrease the amount and frequency of toxin used as possum populations with compromised breeding will take longer to recover after conventional control operations.

The first step has been to show that an immunocontraceptive vaccine will work and make possums infertile. Previously, Landcare Research scientists showed that immunising female possums with possum sperm reduced the number of young born by 80%. Now Janine Duckworth, Denise Jones and Susie Scobie, have extended this research to target the possum egg. To do this, they collected thousands of eggs from the ovaries of pigs, and using the outer coat of these eggs (the zona pellucida or ZP), made a vaccine and injected it into female possums. Pig ZP vaccines have been shown to reduce the fertility of many animals but have never before been tested in marsupials.

In this novel trial, the possum's immune system reacted to the pig ZP and produced antibodies to it (Fig. 1). These antibodies attached to the possum's own eggs, which have a similar coating to that of the eggs of pigs, and prevented sperm from binding to the egg and fertilising it. Vaccinated possums continued to have normal oestrus cycles but when they mated, 75% fewer conceptions occurred than for unvaccinated possums, and significantly fewer young possums were born. Janine's team now know that a vaccine targeting the reproductive system of the possum can greatly reduce its breeding success.

The next step in the research programme is to make a vaccine that is as possum-specific as possible. Australian collaborators Karen Mate and Carmen McCartney from the Marsupial Cooperative Research Centre at Macquarie University visited New Zealand and collected hundreds of eggs from the ovaries of wild-caught possums, and from them isolated three key proteins that make up the outer coat of the possum egg. The genes for two of these proteins, ZP2 and ZP3, have now been cloned and identified. This means that quantities of these specific proteins can be

*Injecting a female possum with pig ZP vaccine.*

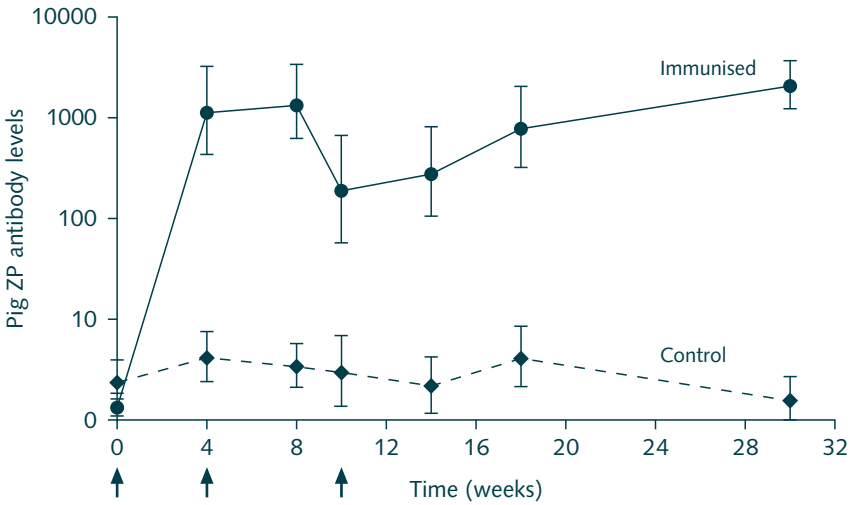



*Fig. 1. Anti-ZP antibody levels (±) in the serum of immunised and control female possums. Arrows indicate vaccination times.*

manufactured for testing. The contraceptive potential of possum ZP3 is currently being evaluated in laboratory and pen trials at Lincoln. In time, the trans-Tasman team aim to develop contraceptive vaccines that will make only possums infertile and be harmless to humans or any other animals.

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

***Janine Duckworth, Denise Jones*** *and* ***Susie Scobie*** *are in the Pest Impacts and Management team of Landcare Research based at Lincoln, and members of the Cooperative Research Centre for the Conservation and Management of Marsupials.*

# Effective Possum Control Reduces Bovine Tb Infection in Cattle and Possums

Since bovine tuberculosis (Tb) is self-sustaining in possum populations, cattle and deer management alone will not eradicate the disease from livestock, as they may be continually reinfected from infected possum populations. One-off large-scale control operations against possums as practised in the 1970s and 1980s generally achieved only temporary reductions of Tb in cattle. More recently, modelling studies have suggested that a strategy of a large initial knockdown in the possum population, followed by regular (maintenance) control, should eradicate Tb from possum populations and from livestock.

*Part of the Hohotaka study area.*

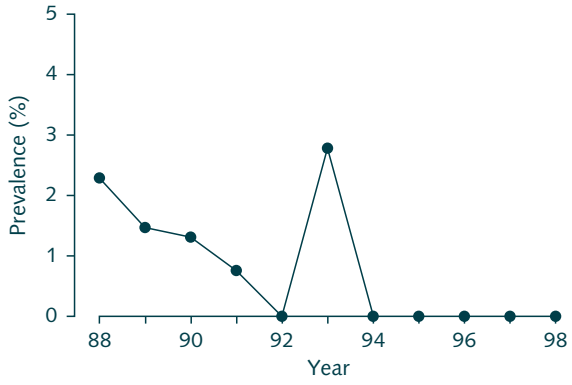



*Fig. 1. Changes in the prevalence of grossly tuberculous possums caught at Hohotaka after the start of intensive possum control in 1988.*

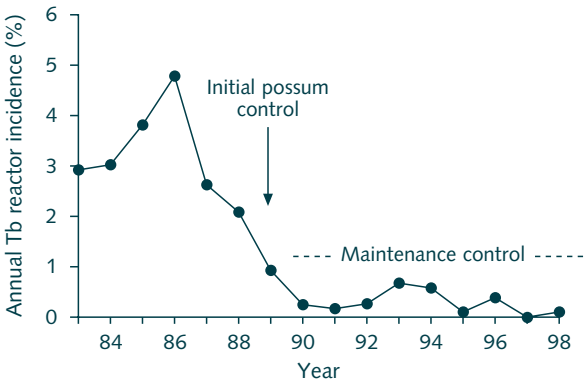



*Fig. 2. Changes in the incidence of Tb reactor cattle on 6 farms at Hohotaka after starting intensive possum control.*

In 1988, Graham Hickling (followed by Peter Caley) in collaboration with staff from MAF Quality Management (now AgriQuality New Zealand) initiated a study to assess changes in the prevalence of Tb in possums and in the yearly incidence of Tb in cattle herds in an area where the possum population was to be subject to sustained control. The study focussed on a 1200-ha block of farmland comprising six mainly beef breeding units at Hohotaka in the central North Island. The block lies in a Tb Vector Risk Area where the yearly incidence of Tb in cattle increased more than 3% per annum in the six years before the start of possum control.

Intensive possum control was initiated at Hohotaka in June 1988, and achieved an immediate reduction in the possum population of 89%. Routine annual maintenance control of possums followed from 1988 to 1998, and has maintained the possum population at an average of 22% of its original density.

During the first year of control, 2.3% (20 out of 877) of possums necropsied were grossly tuberculous (Fig. 1). These infected possums were tightly clustered on or adjacent to farms with the highest annual incidence of Tb in cattle. Tuberculous possums were again found in the same locations, though at a declining prevalence during surveys in 1989, 1990 and 1991. No Tb possums were found in 1992, and it seemed that the control intensity was sufficient to eradicate the disease from possums. However, in 1993, further Tb possums were identified, in exactly the same locations as before. This was reflected in an increasing reactor incidence in the cattle herds (Fig. 2). The intensity of maintenance control of possums was then increased and produced positive results; from 1994–1998, none of 665 possums necropsied were grossly infected, suggesting that the ongoing control had finally eradicated Tb from the possum population (Fig. 1). The inclusion of areas surrounding the study site in the possum control zone in 1996 appears to have played an important part in further reducing the incidence of Tb in cattle.

Possum maintenance control has reduced the mean annual incidence of Tb in cattle about Hohotaka by greater than 90% (Fig. 2). As of 1 September 1998, none of the six Hohotaka herds were on movement control (i.e., contained cattle suspected of being infected), which was very different from the 1980s, when in some years all the herds were infected and on movement control, and as many as 50 reactors occurred per year.

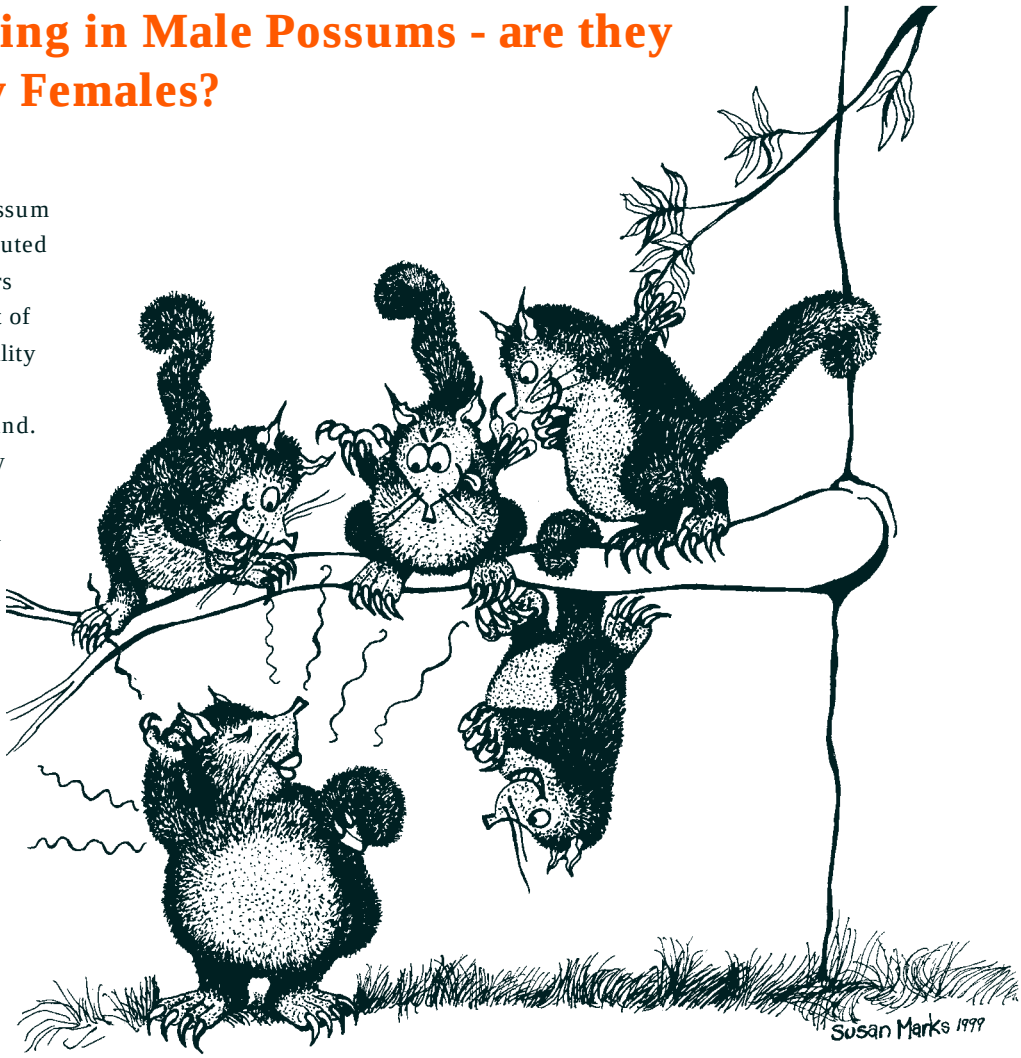
Graham and Peter have identified a few important lessons from Hohotaka. First, possum control must be intensive and occur over all areas where Tb possums occur. Second, control needs to be sustained for several years to control Tb in possum populations. Where Tb is established in possum populations, it takes a concerted effort to eradicate it. However, the longer possums are controlled, the greater the rewards.

This work was funded by the Animal Health Board.

***Peter Caley*** *is in the Wildlife Ecology, Tb and Biocontrol team of Landcare Research based at Palmerston North.*

***Graham Hickling*** *is in the Ecology and Entomology Group of Lincoln University.*

# Seasonal Breeding in Male Possums - are they Switched on by Females?




The common brushtail possum is the most widely distributed Australian marsupial, and occurs throughout Tasmania and most of mainland Australia. Its adaptability undoubtedly contributed to its success in colonising New Zealand. In most of Australia and in New Zealand, possums are seasonal breeders, giving birth mainly in autumn but with births in all months of the year in some regions. The onset of the possum breeding season, as in many mammals, is controlled by day length. Australian scientists have shown that changing possums from a summer day length to an autumn day length brought forward the start of the breeding season, and vice versa. However, male possums produce sperm all year but have seasonal changes in prostate gland size and levels of the hormone, testosterone. What controls these seasonal changes is unknown. One hypothesis is that males are stimulated by females coming into oestrus, and the increased levels of testosterone result in behavioural changes and increased aggression between males for access to females.

Terry Fletcher, Denise Jones and Susie Scobie studied the effects of social grouping on seasonal reproduction in mature male possums for two years. In the first year, male possums were kept in grassy outdoor pens in groups with two females. They were weighed, their testes measured, and urine and blood samples taken at 2-3 week intervals. The team discovered that male possum body weight was highest at the onset of breeding and lowest at the close of breeding. A marked peak in testosterone secretion was correlated with the onset of breeding, whilst testis volume and sperm numbers showed no seasonal pattern of change.

In the second year, six male possums were penned individually with females whose ovaries had been removed (ovx) to stop them undergoing oestrous cycles. Another six males were penned with females sterilised by tubal ligation (TL). These females had normal oestrus cycles but could not become pregnant. A third group of six males were caged alone approximately 30 m from the nearest female. All male possums were measured and sampled as in the first year of the study. Here, Terry and his team discovered that the seasonal changes in body weight and testosterone levels (Fig. 1), and the lack of significant change in testis volume or sperm count, occurred in each group of male possums irrespective of the presence or absence of cycling or non-cycling female possums.

These results do not support the original idea that changes in the reproductive system of males are switched on by female possums. It is possible that the isolated males were not sufficiently separated from pheromone or other signals from female possums, but it appears equally

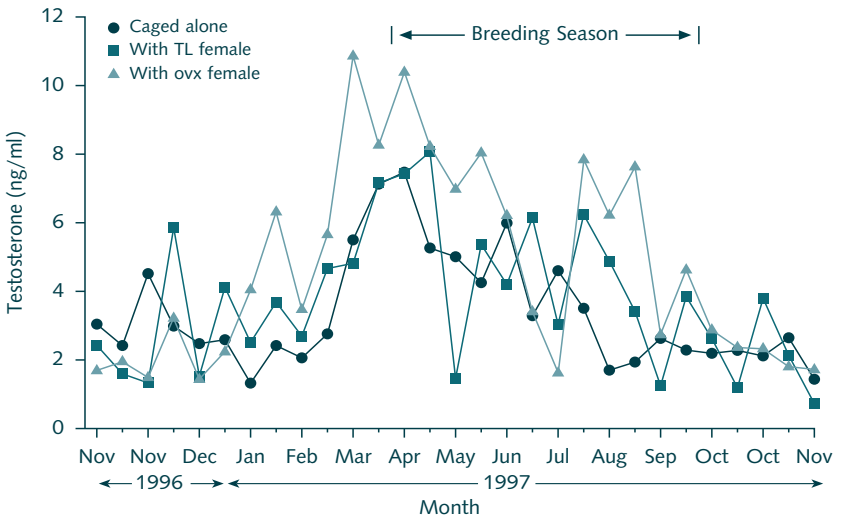



*Fig. 1. Testosterone levels for male possums when caged either alone, with females sterilized by tubal ligation (TL), or with females whose ovaries had been removed (ovx).*

likely that the observed seasonal changes in male possums are driven by day length, as they are in females.

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

***Terry Fletcher*** *has recently left Landcare Research to become Director of Research at the Perth Zoo.*

***Denise Jones*** *and* ***Susie Scobie*** *are in the Pest Impacts and Management team of Landcare Research based at Lincoln.*

# How Deep into the Forest Should Possums and Deer be Controlled to Manage Bovine Tb?

The principle strategy for eliminating tuberculosis (Tb) from wildlife and reducing the level of Tb in nearby livestock is aerial baiting of possums followed by ground-based maintenance control. For example, in the winter of 1994, forest buffer zones of 1-, 3- and 7-km deep adjacent to the pasture margin about the Hauhungaroa Range were aerially sown with carrot bait loaded with 1080 toxin to control Tb populations of possums and deer. Each year since then, possums along adjacent forest margins were controlled by ground baiting. The design of the pest control allowed Landcare Research staff led by Jim Coleman, Wayne Fraser and Graham Nugent to compare over five years:

- the rate of recovery of the populations of possums and deer in each buffer,
- the levels of Tb in possums living on the forest margin and in deer living within the forest, and
- the effectiveness of the different buffer zones in reducing the incidence of Tb in cattle on nearby farmland.

*Tb levels in livestock are affected by wildlife carriers of Tb.*

Each year, beginning in 1994 immediately prior to the baiting, Landcare Research staff measured the density of possums and deer (using faecal pellet surveys) in each buffer (Fig. 1). In addition, possums were trapped on the forest margin and within the 3- and 7-km buffers, and deer were shot and recovered from the 7-km buffer and non-treatment area. Carcases of both species were checked for Tb.

After four years of study, some clear implications are emerging for the future management of Tb in wild animals. Possum densities in the 3 buffers were initially reduced by 78% to 92%. Since that time, density in the 1-km buffer has recovered to 81% of pre-control density. This appears unacceptably high, exceeding the '40% of pre-control density' suggested by modelling theory to be the upper limit for Tb elimination. Possum density in the 3-km buffer is more acceptable, having recovered to more modest levels (25%), while density in the 7-km buffer remains low (10% of pre-control density).

Initial reductions in deer numbers were lower than that of possums, and greatest reductions (42% ) were recorded in the 7-km buffer. Deer densities have since recovered to pre-control levels in both the 1- and 7-km buffers, but are still lower in the 3-km buffer.

Only four possums have been diagnosed with Tb in 5 years of sampling. Tb prevalence in possums in the 3- and 7-km buffers exists at very low levels (< 1%), and appears similar to that recorded 15 years earlier. That said, there are clearly fewer possums currently present in two of the three buffers. Hence fewer infected possums are living in the forest or foraging amongst stock on forest margins.

By comparison, Tb prevalence in deer originally was higher (37%) than for possums. Since poisoning, rates of infection in deer in the 7-km buffer has fallen to 6%. Graham hypothesizes that Tb in deer results primarily from possum to deer transmission. In our study, the falling prevalence in deer reflects artificially reduced possum numbers.

*Table 1. Tb testing data from herds adjacent to all three buffers.*

| Year | 90/91 | 91/92 | 92/93 | 93/94 | 94/95 | 95/96 | 96/97 | 97/98 |
|---|---|---|---|---|---|---|---|---|
| No. of cattle tested | 15706 | 18922 | 23276 | 19665 | 25727 | 20949 | 18212 | 20307 |
| % of cattle with lesions | 0.92 | 1.19 | 1.04 | 0.67 | 0.43 | 0.29 | 0.19 | 0.14 |

Tb infection rates in cattle herds adjacent to all three buffers have generally declined since the 1994 poisoning, and are now at their lowest (0.14% ) since the study began (Table 1). Levels of infection in cattle are currently lowest adjacent to the 7-km buffer (0.09 – 0.13%) where possum numbers are lowest, and highest adjacent to the 3-km buffer (0.23%) where possum numbers are highest.

Currently, it is unclear whether the slightly greater benefits of possum and deer control in reducing Tb in cattle in herds adjacent to the 7-km buffer are sufficient to warrant the expense of control over such a wide buffer. Controlling such extensive buffers is expensive, and the cost may outweigh the benefits gained from more conventional wild animal control.

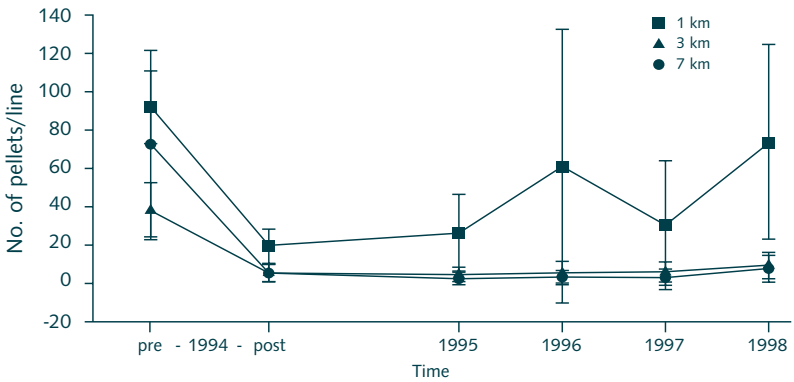



*Fig. 1. Changes in possum faecal pellet densities over time within the 1-, 3-, and 7-km buffers.*

This work was funded by the Animal Health Board.

***Jim Coleman, Wayne Fraser, and Graham Nugent*** *are in the Pest Impacts and Management team of Landcare Research based at Lincoln.*

# Zinc Phosphide: A Potential New Toxicant for Possum Control

Repeated use of the poison 1080 in some areas in New Zealand has resulted in it becoming less effective against possums, as many survivors develop a shyness to 1080 that may persist for two or more years. Furthermore, the widespread use of 1080 in New Zealand is of public concern because of the perceived risks to human health and non-target animals. Charlie Eason has been leading research into acceptable alternative toxicants. Zinc phosphide appears very promising. It is already used as a rodenticide in many countries because of its low cost, wide acceptance by pest species, and lack of environmental persistence. When eaten, zinc phosphide is degraded in the stomach by gastric acids and converted to phosphine gas, which is largely responsible for its acute toxic effects.

Charlie's team have shown that zinc phosphide is an effective toxicant for possums at lower oral doses (25 mg/kg) than those reported in other mammals. The mean time to the onset of clinical signs in lethally-dosed possums is 1.5 – 2 hr, while the mean time to death is dose-dependent but ranges from 2.2 – 5 hr (Table 1).

During the next stage in evaluating zinc phosphide, the team tested its effectiveness in various bait formulations. While possums normally eat an average of around 20 g of non-toxic cereal bait from bait stations, they eat less than 3 g of 2% zinc phosphide-treated bait, resulting in poor kills of about 58%.

The low palatability of zinc phosphide-loaded cereal baits to possums may be due to the strong, garlic-like taste and odour of this compound, the rapid release of phosphine gas, or the early onset of nausea. Clearly, in order to achieve an acceptably high mortality rate, it is necessary to mask the odour and taste of the compound, and to slow its release from bait. Dave Morgan in collaboration with specialists in the USA, is trying to do this by encapsulating the compound. Encapsulation may also slow the onset of anorexia in possums, using minimal concentrations of toxicant in the bait or reducing the amount of bait required. This would reduce both the cost of bait application and the risk to non-target animals. Encapsulation may also increase the storage life of zinc phosphide baits.

Criteria for the development of encapsulated zinc phosphide (Table 2) are based primarily on conditions encountered during its passage through the digestive tract of the possum. Additionally, the product must withstand bait manufacturing conditions, but break down once distributed in the environment.

Dave and Charlie see zinc phosphide as a potentially suitable alternative to 1080 for possum control. Nevertheless, they believe that re-evaluating existing data and completing further 'safety' studies of this compound are necessary to meet new registration standards in New Zealand. There is a clear need for encapsulating zinc phosphide, and if this can be achieved, an effective new product for possum control will become available.

*Table 1. Onset of clinical signs of poisoning and mortality in possums dosed with zinc phosphide (n = 3 for each dose).*

| Dose (mg/kg) | Mean time to onset of clinical signs (hr) | Mean time to death (hr) | Mortality (%) |
|---|---|---|---|
| 0 | N/A | N/A | 0 |
| 5.0 | 3.5 | N/A | 0 |
| 25.0 | 2.0 | 5.0 | 100 |
| 50.0 | 2.0 | 5.0 | 100 |
| 100.0 | 1.5 | 2.2 | 100 |

*Table 2. Specifications for the development of encapsulated zinc phosphide.*

| Characteristic | Specification |
|---|---|
| Particle size | <0.5 mm |
| Release characteristics | 100% release in 20 min at pH 2.5 and 36°C |
| Manufacturing | Withstand 65°C and 25 psi for 20 min |
| Stability | Stable at ambient temperature in dry storage for 12 months |
| Cost | <$30 per kg finished product |
| Environmental breakdown | Capsule contents released in 6 weeks, assuming 25 mm rain |

This work was funded by the Animal Health Board.

***Dave Morgan*** *and* ***Charlie Eason*** *are in the Pest Management and Wildlife Ecotoxicology team of Landcare Research based at Lincoln.*

# Contacts and Addresses

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# A Selection of Recent Possum-Related Publications

**Bellingham, P.J.; Wiser, S.K.; Hall, G.M.J.; Alley, J.C.; Allen, R.B.; Suisted, P.A. 1999**: Impacts of possum browsing on the long-term maintenance of forest biodiversity. Science for Conservation Series No. 103. Department of Conservation. 59p.

**Caley, P.; Spencer, N.J.; Cole, R.S.; Efford, M.G. 1998**: The effect of manipulating population density on the probability of den-sharing among common brushtail possums and implications for transmission of bovine tuberculosis. *Wildlife research 25*: 383-392.

**Duckworth, J.A.; Scobie, S.S.; Jones, D.E.; Selwood, L. 1999**: Determination of oestrus and mating in captive female brushtail possums *Trichosurus vulpecula* (Marsupiala: Phalangeridae) from urine samples. *Australian journal of zoology 46*: 547-555.

**Jolly, S.E.; Spurr, E.B.; Cowan, P.E. 1999**: Social dominance and breeding success in captive brushtail possums, *Trichosurus vulpecula. New Zealand journal of zoology 26*: 21-25.

**Mate, K.E.; Molinia, F.C.; Rodger, J.C. 1998**: Manipulation of the fertility of marsupials for conservation of endangered species and control of over-abundant populations. *In:* Brown, J.L. and Wildt, D.E. (Eds). Reproduction in Wildlife Species. *Animal reproduction science 53*: 65-76.

**Nutman, A.W.; Gregory, N.G.; Warburton, B. 1998**: A comparison of the effectiveness of three neck-hold killing traps in occluding carotid arteries in the neck of the brushtail possum. *New Zealand veterinary journal 46*: 177-181.

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Editors: Jim Coleman, Caroline Thomson
Layout: Kirsty Cullen
Cartoons: Susan Marks
Published by: Manaaki Whenua, Landcare Research, PO Box 69, Lincoln, New Zealand
ph +64 3 325 6700
fax +64 3 325 2418
Also available electronically: http://www.landcare.cri.nz/information_services/publications/#news
ISSN 1173 - 2784