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Can North American Beavers Be Eradicated from Tierra del Fuego?

North American beavers were introduced to the island of Tierra del Fuego in 1946 to start a fur industry. They have since spread over the entire island, swum the Beagle Channel to Navarino and other islands, and recently swum the Straits of Magellan to mainland South America. Beavers now occupy about seven million hectares of southern beech forest, Patagonian steppe, and Andean high altitude bogs, and occupy about 26,000 km of waterways with a frequency of about one colony every 2 km.

Some people still make part of their living by trapping and exporting beaver pelts, but by and large the introduction has been a disaster. Beavers destroy riparian beech forest, damage roads, and are a nuisance to farmers and foresters.

Chile and Argentina have recently signed a treaty to manage biodiversity in Tierra del Fuego, and have been considering what to do about beavers. In 2007, the governments of both countries and the Wildlife Conservation Society commissioned an international team led by John Parkes to assess options to manage beavers, and in particular whether they might be eradicated from South America.

At first glance, eradication might seem impossible. The scale of the problem is huge, much of the area is unroaded wilderness, any solution would require cooperation between two countries that have not always seen eye-to-eye over where the border lies on Tierra del Fuego, neither country has a strong pest control capacity, and some local people value

John Parkes

Riparian southern beech forest killed by beavers at a site they have abandoned, and replaced by meadow now used by feral horses, cattle, and native guanaco beavers. But, people said rat and other island pest eradication programmes were impossible only a few decades ago, and now rats have been removed from islands of up to 11,200 ha, goats from 500,000 ha, pigs from 58,000 ha and possums from 2,900 ha – with even grander plans being considered.

There are two ways to assess the feasibility of eradication of beavers: past success elsewhere, and an analysis of the issues, risks and constraints pertaining in Tierra del Fuego.

Past success: True eradication has been achieved for only a few tiny populations introduced (or escaped) in France. However, both the North American beaver and its European cousin were exterminated in the last 300 years from vast areas of North America and Europe by overhunting, only to reinvade areas or be reliberated once hunting declined. In North America, beavers are now often a pest and are controlled by agencies such as the US Department of Agriculture using traditional methods of trapping, snaring, and shooting, with modern improvements in efficiency and humaneness.

Analysis of the risks and constraints: Eradication requires that all animals be at risk and killed fast enough to exceed their replacement rates, that immigration is zero, and that any unwanted consequences are outweighed by benefits. Chilean and Argentinean hunters can meet these rules for a colony of beavers and kill them all within a few days. So, the question is whether they can do that along an entire catchment occupied by beavers, and across their entire range. The main biological risks are not doing it quickly enough or with enough monitoring to limit or deal with

The North American beaver is amongst the largest of rodents and eats leaves, bark, twigs, roots and aquatic plants.

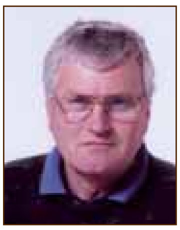
beavers that disperse back into cleared areas.

Beavers do have one Achilles' heal; they build obvious dams in streams or live in lodges built along the edges of lakes – and these are visible from the air (maybe even from satellites). Thus, detecting beavers may be simpler than detecting other mammalian pests. A hole can be made in any dam from which beavers are thought to have been removed, and if it is repaired (i.e. the dam fills with water), hunters can return and deal with the survivors or immigrants.

Apart from the biological risks, there are technical and management constraints that arise from the scale of the operation, the inaccessibility of the area occupied, and the need to develop project management and delivery skills. These can all be addressed, but at a cost – John's team estimated this at about NZ$40 million over at least 5 years plus any ongoing surveillance. There are also the usual constraints that have to be managed in any pest eradication operation: native otters are present in some catchments, limiting the type of control that can be used; ensuring social acceptance to gain access to lands of all tenures requires careful public consultation; and a project team has to be developed to deliver the desired result.

Despite the daunting scale and remoteness of the area, eradication is technically possible, provided sufficient funds are allocated, and governance and management structures are developed that can overcome the constraints identified plus any not predicted that may arise.

This project was funded by the Comité Binacional para la Estrategia de Erradicación de Castores de Patagonia Austral.



John Parkes

parkesj@landcareresearch.co.nz

Predicting Biodiversity Outcomes from Pest Control in Dryland Environments

Managing pests does not always protect the plants and animals we value. Even when it does, there can be unintended consequences for other parts of the ecosystem, especially in complex food webs. Pest species rarely occur in isolation from other pest species, so they often have direct and indirect impacts on more than one native species. Conservation pest management requires a better understanding of these interactions so that ecosystems can be managed as a whole.

Such interactions are being investigated in a dryland ecosystem in Otago. Here, pest herbivores (rabbits, hares, possums), top-order predators (cats, stoats, ferrets, weasels), mesopredators (mice; also prey for top predators), and insectivores (hedgehogs) interact with each other (*Fig. 1*).

Native lizards and invertebrates are threatened directly and indirectly by this suite of pests. The conventional approach by managers in New Zealand is to remove the immediate threat – in this case the top predators that eat lizards. But that can potentially give rise to an increase in mesopredators (mice), which may lead to even greater damage given their ability to access rock crevices and prey on lizards. Removing top predators may also give rise to more pest herbivores resulting in lower biomass of ground-level vegetation. Low vegetation cover inhibits dispersal of lizards and probably reduces the availability of their food. So is controlling pest herbivores a better

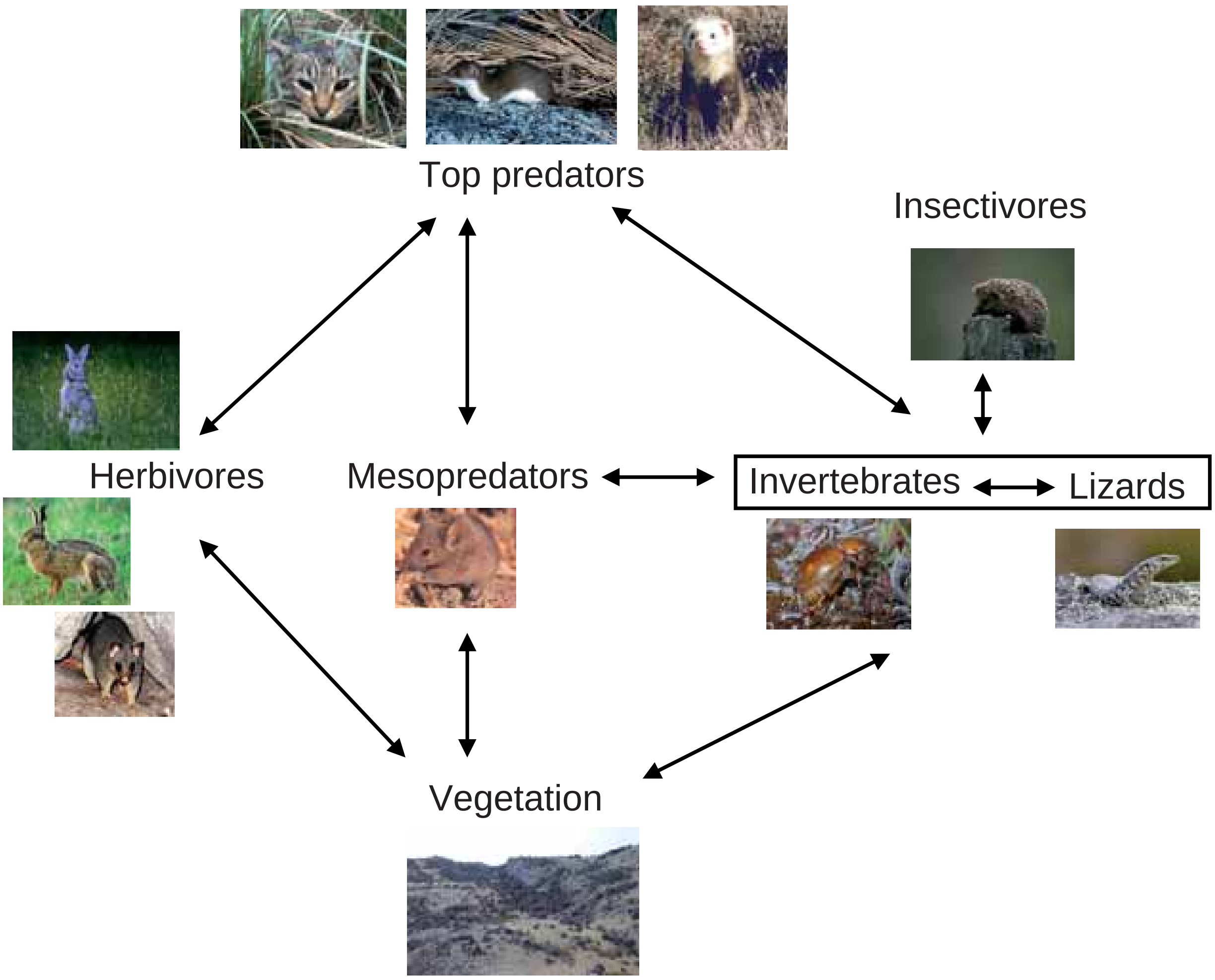


Fig. 1. Simplified food web from the study site. Direct interactions are shown by arrows: e.g. top predators kill lizards, mice and rabbits, and their availability determines the number of top predators. Indirect interactions result from combinations of direct interactions: e.g. top predators kill mice, which in turn influence the availability of invertebrates for lizards

approach in this situation? Not only does reducing herbivores reduce predators that rely on them as prey, but it also enhances vegetation that might benefit lizards.

In making such decisions, managers generally have to rely on qualitative information collected in a piecemeal fashion. This may change; Grant Norbury and his colleagues are developing ecosystem models to assess the potential consequences of single- and multiple-species pest control. One way of improving predictions with these models is to make use of established thresholds in relationships between species; small changes near thresholds are likely to have large consequences for the species managers wish to conserve. For example, the Department of Conservation's Grand and Otago Skink Recovery Programme has identified the level of predator abundance needed to allow recovery of these skinks. Similarly, Landcare Research has identified that at least 50% cover of ground vegetation is required to support common skink populations *(Fig. 2)*.

Some of the modelling completed so far predicts that small common lizards in especially dry habitats will continue to decline even with control of top-order predators. The team is testing this prediction with a large-scale experiment using two predator-removal and two non-removal treatments. Preliminary results confirm the lack of recovery of common lizard populations under both scenarios.

But why have lizards failed to respond to predator removal? Possible explanations include:

- Increased predation from mice. This was predicted by the model, but is not supported by evidence from the experiment so far.
- Competition for invertebrates with hedgehogs. This is unlikely given that hedgehogs mostly eat different types of invertebrates than those consumed by lizards.
- Predator numbers had already been reduced before the experiment began. There is good evidence for declines in predator numbers 10 years ago when rabbits declined following the introduction of rabbit haemorrhagic disease.
- The size of the predator removal sites (420 and 650 ha) may be too small to overcome the effects of constant immigration of predators.
- Insufficient time has elapsed for prey species to respond to predator removal. Lizards may require more than the 20 months of the treatment imposed to increase to detectible levels.
- Processes other than predation and competition are limiting lizards. The habitat for skinks on the experimental sites has been highly modified by pastoralism. Native shrubs and tussocks have been severely reduced in abundance, and now provide little shelter and food for lizards.

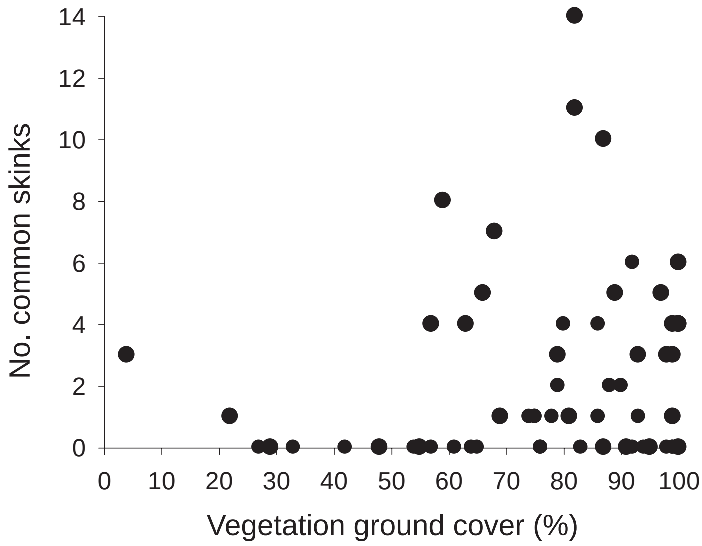
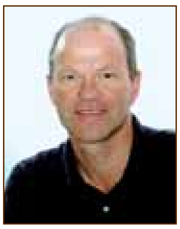


Fig. 2. *Relative abundance of common skinks captured from areas with varying amounts of ground vegetation. Skink numbers suddenly increase when ground cover is greater than about 50% compared with sparse vegetation*

The researchers will continue to measure ecosystem responses to predator removal for the next 12 months. One option for the future is to manipulate native shrub and tussock cover, in the presence and absence of predators. The relative effects of habitat quality, predation, and their interactive effects are important considerations for future restoration ecology in New Zealand.

This research is funded by the Foundation for Research, Science and Technology, in collaboration with the Department of Conservation.



Grant Norbury
norburyg@landcareresearch.co.nz
Andrea Byrom, Roger Pech and James Smith
(not shown)

Affordable Tb Control for the High Country

Many landowners and pest managers throughout the Northern South Island High Country are faced with controlling several wildlife species (vectors) infected with bovine Tb across extensive, largely unforested, mountainous terrain in order to control the disease in livestock. As it is impractical to undertake vector control over the entire area, a team led by Andrea Byrom and Graham Nugent, along with colleagues from Massey University, were asked to identify which vector species should be controlled to give the best chance of breaking the Tb cycle in local wildlife, and which habitat types should be targeted to give the greatest benefit for Tb control across the region. The project ran for 3 years and was based on Molesworth Station, a dry mountainous area of inland Marlborough.

Molesworth Station is home to infected possums, ferrets, feral pigs and wild deer. To identify which of these species to target for Tb control, the researchers experimentally removed possums, ferrets, and feral pigs one species at a time from separate treatment areas. Where pigs were present, the level of Tb in them was used to indicate the level of Tb in all vectors in each area (as pigs are particularly susceptible to Tb). In areas where pigs were absent, ferrets were used as the indicator of Tb presence.

Aerial 1080 control of possums alone produced the largest reduction in Tb levels, compared with controlling only pigs or only ferrets. Following an aerial 1080 operation targeting possums, Tb levels in pigs fell from around 80% to just 10% within 2 years. The significance of this decline in the disease following possum control showed that even where possums are at low density, controlling possums gives the single largest direct benefit.

By comparison, controlling pigs (and removing the carcasses) did little to reduce Tb in this species. Likewise, targeting ferrets for several years only resulted in a small decline in Tb in their populations compared with Tb levels in ferrets in areas without ferret control.

Given that the research showed that possums were by far the best species to target, the next step was to determine where possums should be controlled with most effect on Tb. The distribution and abundance of possums across Molesworth Station were mapped using a

Andrea Byrom

Landcare Research field staff survey an expansive area of Molesworth Station. Targeted possum control rather than control of all Tb hosts over all habitats is likely to be more cost-effective for reducing Tb in this habitat trap-catch index, obtained from randomly placed traplines running from ridge top to valley bottom throughout the station. These data indicated which habitats and areas held the highest possum densities, and hence which had the greatest likelihood of endemic Tb. Habitat variables (e.g. altitude, vegetation, slope and aspect) from each trap site were used to predict where possum densities were likely to be highest and where possums were likely to be in such low numbers that they were unlikely to host Tb.

Using a GIS (geographic information system) to overlay these data with digital environmental data, the team created a model that predicted, in simple three-dimensional terms, possum densities across the entire Northern South Island High Country – even for parts of the landscape that the team had not surveyed directly (*Fig.*)
These results, showing that the possum is the best species to target for control of Tb, combined with maps of predicted possum distribution throughout the landscape, enable areas for control to be prioritised and areas to be excluded. This landscape-level capability means farmers, vector managers and contractors can maximise the effectiveness of their Tb-vector control budgets by targeting priority areas.

With digital mapping technology and sophisticated GPS systems on aircraft, aerial 1080 poison operations can now be far more site-specific. Further, by using the latest digital mapping databases combined with field data obtained in this research, most control operations can now be planned entirely in the office resulting in more cost-effective control operations across Molesworth Station and other similar landscapes.

Ivor Yockney

Pig carcasses recovered during aerial shooting operations were surveyed for evidence of Tb

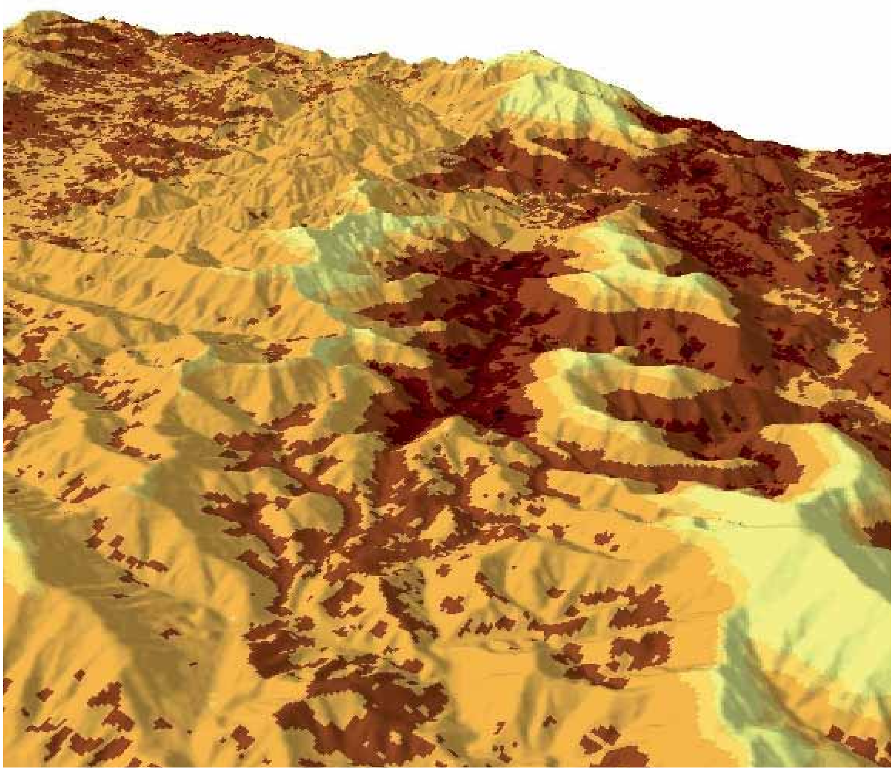


Fig. *Digital mapping image of Molesworth Station looking towards the north-eastern boundary. The darker the colour, the higher the predicted possum abundance*

This work was done under contract to the Animal Health Board with additional funding from Landcorp Farming.

Ivor Yockney
yockneyi@landcareresearch.co.nz

Andrea Byrom, Graham Nugent, Nick Poutu, Jackie Whitford, James Shepherd, Joanna McKenzie (Massey University) and Thibaud Porphyre (Massey University)
(not shown)

Parasites Lost: Did They Miss the Boat or Drown on Arrival?

A key reason exotic species do particularly well following introduction to a new environment may be that they leave behind all or some of their natural enemies – their competitors, predators, pathogens or parasites. A flurry of recent studies has shown that exotic populations commonly have fewer parasites than populations of the same species in their native range. However, the mechanisms by which species lose their natural enemies aren't clear. Greater understanding would help in identifying exotic species that may 'benefit' from escaping their enemies. This knowledge is also important in understanding and reducing the risk of incursions of exotic parasites or diseases that could cause widespread harm to native or commercially important species.

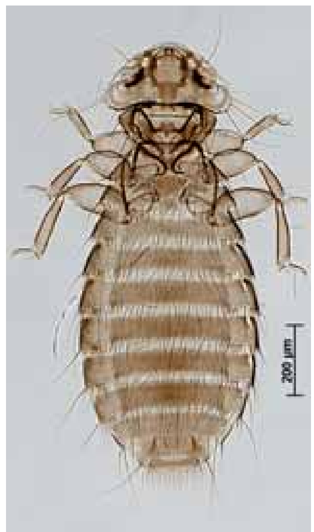
When a host species is introduced into a new environment there are three ways its parasites could fail to establish there. First, a parasite may simply 'miss the boat'; none of the individual hosts introduced happened to be infected with the parasite. Missing-the-boat events are most likely to occur when levels of parasite infection are low or patchy in the host's native range, or when few hosts are introduced. Second, even if it makes it 'onboard', a parasite will fail to persist if its host fails to establish; it 'sinks with the boat'. Finally, some parasites may be 'lost overboard'; they arrive with their host, the host successfully establishes, but the parasite fails to persist for other reasons.

While these pathways are well defined, it has proven extremely difficult to assess their relative importance because little is known about the ecological context in which species introductions occur. Fortunately in New Zealand, the introduction of exotic birds with their associated ectoparasitic chewing lice provides a rare opportunity to test these ideas; bird introductions to New Zealand have been well documented, and chewing lice are a well-studied group. Catriona MacLeod and her colleagues used a combination of field surveys, data collation from literature records, and museum collections to compile records of bird and parasite distributions in both their native and exotic ranges. They also used the records of bird introductions, including the number of host individuals introduced.

Overall, chewing lice had a low chance of 'missing the boat' (<12%), but a high chance of 'sinking with the boat' (>30%) or being 'lost overboard' (>20%; *Fig.*) when their hosts were introduced into

Catriona MacLeod

The yellowhammer, which is one of the passerine species introduced successfully to New Zealand from the UK, being examined for the presence of parasites.



Jan Mackenzie and Sophy Allen

An example of a chewing louse parasite often found under the wings of birds

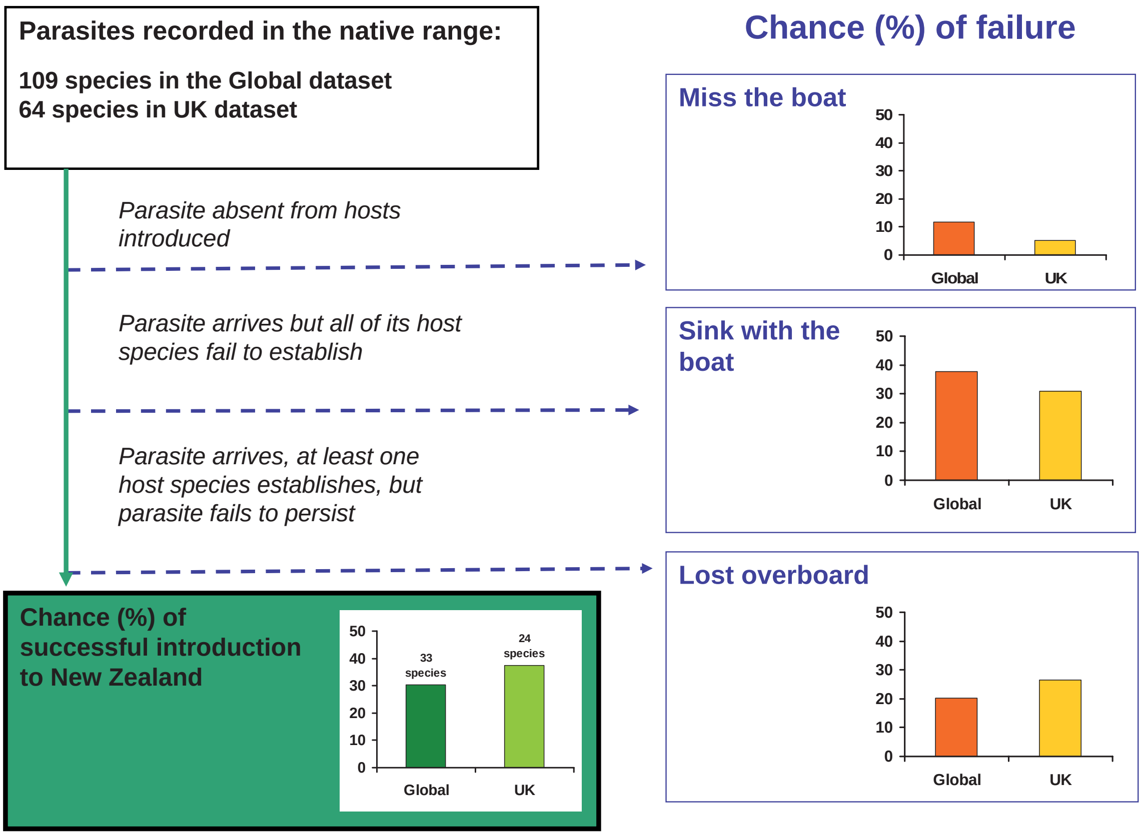


Fig. The chance (or probability, presented here as a percentage) of a parasite being lost at three different stages in the introduction process based on information from (a) a global dataset that assumed that host species and their parasites could have been collected from anywhere in the hosts range outside New Zealand, and (b) the UK dataset, which only included host species and their parasites found in the UK or Ireland

New Zealand. In other words, of the parasite species present in their native range, most would have made it to New Zealand on introduced host populations, but a high proportion of them failed to establish because their hosts failed. Even when their hosts did establish, a high proportion of parasite species still failed for other reasons. More specifically, parasites that arrived in low numbers or were more aggregated on their hosts were more likely to fail. Conversely, parasites were more likely to persist if they had more host species, their hosts had larger founder populations or their hosts had larger body size. These factors probably made it easier for parasites to spread among a host population, which reduced the risk of a parasite population becoming extinct through the chance loss of just a few host individuals.

Contrary to expectation, more mobile parasites or those associated with more social host species were less successful.

This study has important applications in improved border control. Clearly, most parasites do arrive with their hosts. This means that strategies to improve post-border control may be as critical as pre-border screening. Pinpointing factors that favour parasite persistence will enable both pre-emptive management and post-incursion control to be applied in a more guided and efficient manner. Indeed, the capability demonstrated here can now be extended to other groups of infectious agents of concern in New Zealand, including both viral (e.g. avian influenza, swine fever, and Ross River Virus) and bacterial agents (e.g. foot and mouth disease, Lyme disease, and exotic *Campylobacter* and *Salmonella* strains).

This project was funded by a FASTSTART grant from the Royal Society of New Zealand's Marsden Fund.

Catriona MacLeod
macleodc@landcareresearch.co.nz

Adrian Paterson (Lincoln University), Dan Tompkins and Richard Duncan (Lincoln University) *(not shown)*

Are All Possums Susceptible to Trapping and Poisoning?

Possum control and monitoring relies mostly on attracting possums to poison baits and traps. Some possums can be difficult to bait or trap, making control ineffective. Worse, managers relying on trapping to monitor the success of control efforts are likely to end up with what appears to be high kill rates when, in reality, parts of the population may have been missed. To better understand operational failures and to improve the accuracy of monitoring, researchers needed a way of detecting the presence of possums that did not rely on them interacting with monitoring devices.

Dave Morgan, Graham Nugent and Dianne Gleeson took a novel approach to this problem by combining surveys of possums' faecal pellets with DNA fingerprinting. Possums produce around 100 faecal pellets each night, scattered around their home range. Each pellet is coated with a thin layer of mucous that contains cells from the lining of the lower intestine. DNA from these cells can be used to obtain the unique genotype (the DNA fingerprint) of individual possums. Given the large number of faecal pellets produced and the ease of collecting them, it should be possible to identify **all** individual possums in an unbiased way, independently of conventional detection devices. The group used this technique to assess whether the possums were susceptible to trapping and poisoning, by matching faecal DNA with ear-tissue DNA taken from the trapped or poisoned animals.

Extensive faecal pellet searches and 7-night 'trap-and-release' surveys were conducted over a 100-ha site in the Catlins forest just before a control operation. The surveys were repeated 1, 4 and 9 months later. Locations of all trapped possums and faecal pellets collected were logged by GPS and the distances between the 'records' calculated for individual possums. Plastic mesh was suspended above ground to collect pellets defecated by possums in the forest canopy. These were compared with the number of pellets found under the mesh to estimate the proportion of time spent by possums in the canopy.

Possum control was undertaken using Feratox® followed by cyanide paste. Although trap monitoring indicated

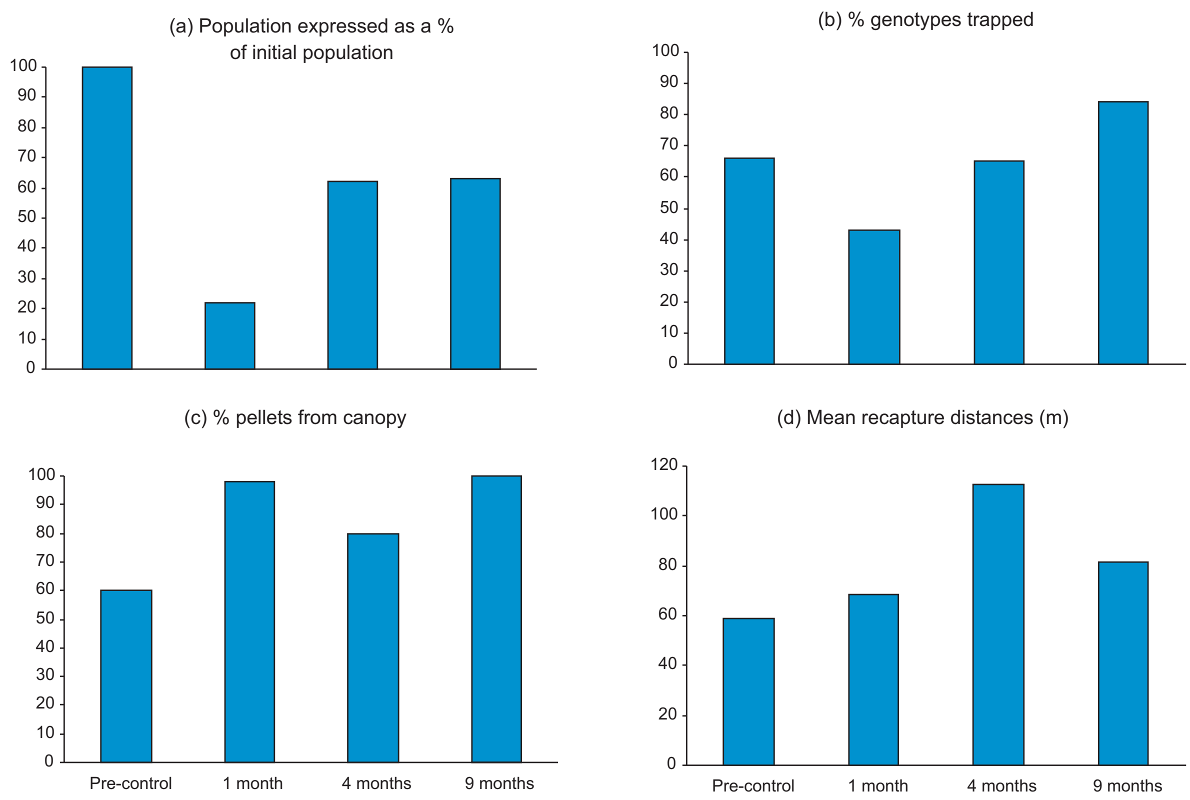
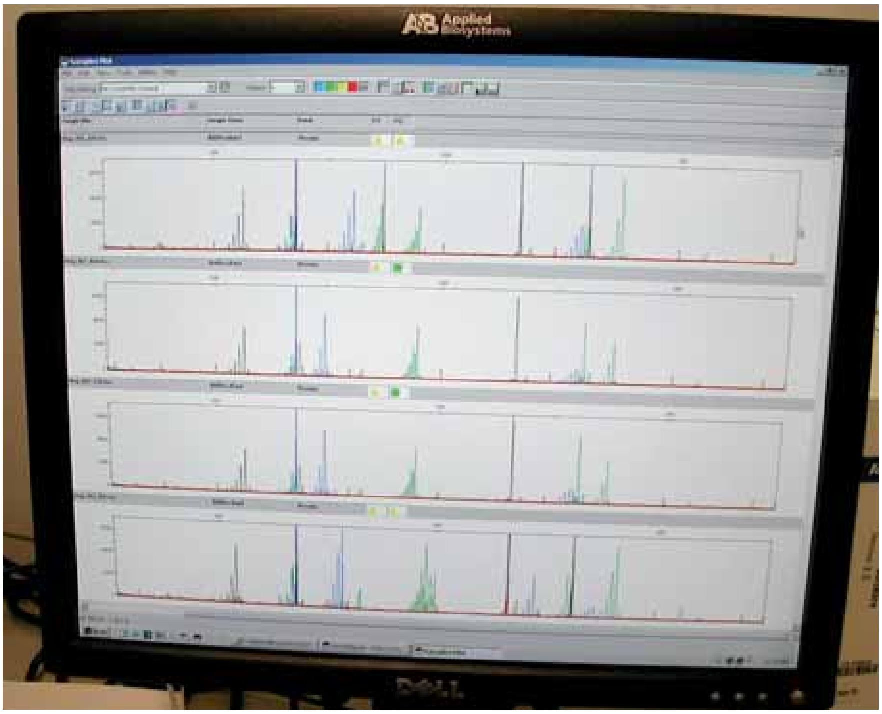


***Fig.** (a) Possum population before and after control as determined by trap catch, (b) trappability of the original population determined from 'mark-recapture', (c) changes in canopy occupancy given by faecal pellets collected on suspended mesh, and (d) changes in possums' movements indicated by mean recapture distances*



DNA extracted from faecal pellets is used to obtain unique genotypes of individual possums. On the screen these can be compared to see if the pellets are from the same or from different possums. The two middle rows show DNA from the same possum

78% of the population had been killed, numbers recovered rapidly over the next 4 months as possums from outside the control site moved in (*Fig.a*). Nonetheless, the team was able to confirm that the possums that survived the poisoning were also, on average, more difficult to trap immediately after poisoning (*Fig. b*). However, the reduced ability to trap possums did not appear to be permanent, as most survivors (identified from faecal DNA) were trapped eventually. Since relatively more faecal pellets were found on the raised mesh 1 month after control, it appears the poison operation selectively removed those possums most active at ground level and left those more active in the canopy (*Fig. c*). Three months later, possums were easier to trap, probably because they were ranging more widely on the ground (average distances between recaptures increased from 68 m to 112 m) (*Fig. d*). Nine months after control, however, possums were again spending more time in the canopy and ranging less widely (82 m between recaptures on average).

An incidental finding was that possums also became harder to trap after being trapped once, but the effect only lasted for 3–4 nights, compared with the long-lasting bait-shyness seen in possums that eat sublethal 1080 or cyanide baits. This suggests the effect is probably linked to reduced movements while possums recover from being held in a trap, rather than from actual trap-shyness.

The key implications from this study are:

- Few, if any possums, appear to be permanently untrappable and unpoisonable, but some may be temporarily so because they spend little time on the ground in some seasons.
- While standard control methods target possums that are active on the ground, sooner or later possums more active in the canopy become more active on the ground, and hence are more likely to be trapped. This explains the impossibly rapid population recovery often observed when monitoring is conducted immediately after control and then repeated later.
- Although possums released from leghold traps are briefly difficult to retrap, this is unlikely to have any effect on trappability in later seasons or years.
- Where baits or traps are available or effective for only a few days, lines of baits or traps must be closely spaced (<75 m) for **all** possums to be exposed to them. However, long-life poison baits, or kill-traps with long-life baits that remain effective over two or more seasons, can be deployed at wider spacing.
- Managers must balance their need for accurate monitoring against the need for prompt assessments so they can pay contractors.

Further research is planned to determine if prefeeding increases the time that 'canopy-dwellers' spend on the ground, and therefore, increases their probability of being trapped.

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

Dave Morgan
morgand@landcareresearch.co.nz

Graham Nugent and
Diane Gleeson *(not shown)*

Kamahi in the Goldilocks Zone: Not Too Tough, Not Too Tasty, but Just Right as an Indicator Species of Possum Browse

It is well known that possums cause environmental damage by browsing native plants in New Zealand forests, but so far, few studies have quantified the damage in a way that helps managers decide when and where control of possums is most beneficial for protection of native forests. Recent reanalysis of an existing extensive dataset has provided some answers. The dataset was collected by the Department of Conservation and Landcare Research as part of large-scale studies to test alternative possum control strategies. In these studies, the impact of possums on kāmahi was measured in two ways: the Foliar Browse Index (FBI), which is the proportion of possum-browsed leaves in the canopy, and individually tagged trees to measure tree survival. FBI represents the current level of browse on a tree, and the accumulated effects of this over a long period reduces tree survival.

Data were available for 1,527 kamahi trees at 21 sites across the North Island. Possum browse was recorded over a period of 8 years, during which time some sites were untreated and some had possum control, resulting in a wide range of possum densities. Richard Duncan and his colleagues used statistical models to quantify the relationship between the level of browse and two factors: possum density and tree diameter. Tree diameter is related to tree height and canopy size, which, together, determine the size of a 'food patch' and whether it is exposed to full sunlight.

The model that best fitted the data shows that as possum density increases, trees on average suffer higher levels of browse – but the increase is not evenly spread; the number of heavily browsed trees increases disproportionately, implying that higher possum densities lead to an accelerating number of severely defoliated trees. In addition, larger trees are more likely to be browsed.

Although there is a clear positive relationship between the average level of browse and possum density, there is also a large amount of variation between trees, years and sites. For example, for the decade beginning in 1994, kāmahi measured in 1999–2003 had consistently lower levels of possum browse than in earlier years. Even after accounting for possum density, possum browse on some sites is much more uneven than on other sites. The result is that on sites prone to uneven patterns of browse, increases in possum abundance will result in an even greater concentration of browse on only a few trees. Since severe defoliation often leads to tree death, increased possum abundance is likely to cause greater reductions in tree survival on sites prone to uneven patterns of browse compared with sites more uniformly browsed.

A preference by possums (and other foliage-eating mammals) for some trees over others of the same species has been observed elsewhere in New Zealand and Australia. Possums can choose between trees on the basis of size (larger trees are bigger patches of food) or palatability (determined by nutrient concentration, leaf digestibility and chemical defence compounds). Earlier work by Landcare Research suggests possums tend to browse the new foliage of defoliated southern rātā, which has higher nutrient concentrations compared with untouched trees.

From the present study, it is apparent that kāmahi is a good 'indicator' species of possum browse: a more palatable species

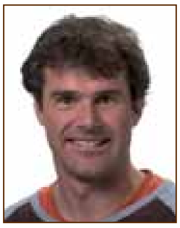
Ian Payton

'Salt and pepper' pattern of defoliation attributed to browse by possums in kāmahi-rātā forest

would always be heavily defoliated and probably rare; a highly unpalatable species would be unresponsive to changes in possum abundance. The pattern of possum-browse on kāmahi, and the likelihood that certain trees tend to be singled out as possum numbers increase, suggest that managers should aim to keep possum numbers consistently low to prevent severe defoliation and death of individual trees. It is especially important to avoid large fluctuations in possum numbers on sites that are prone to uneven browse. At this stage, Richard and his colleagues are unable to predict which sites are more likely to experience uneven browse. Also the high variability due to tree, site and year effects means they do not yet have a simple universal model that managers could use to determine when to impose possum control.

The next stage of this project will explore the links between FBI, a foliage canopy index (FCI), and tree survival.

This research was funded by the Department of Conservation.



Richard Duncan
duncanr@lincoln.ac.nz

Graham Nugent, Mandy Barron and Roger Pech *(not shown)*

Evaluating the Potential of Mechanical Ejector Delivery of Cyanide for Feral Pig Control

In New Zealand recreational hunters generally keep feral pig populations down to levels acceptable to land managers, but when they don't, pig populations can increase and cause significant damage to local agricultural and/or conservation values. In such instances, limited use of poison baiting might provide cost-effective localised pig control, although no poisons are currently registered in New Zealand for this purpose. In Australia, 1080 and yellow phosphorus are registered for feral pig control, with warfarin currently being trialled. None of these poisons was considered acceptable for use against pigs in New Zealand because of humaneness concerns, and secondary poisoning risks in the case of 1080 and warfarin.

Cyanide poisoning is considered relatively humane for species such as possums because it produces unconsciousness within approximately 10 minutes. If a similar rapid 'knockdown' and rapid death in pigs could be achieved, it would represent a significant welfare improvement over currently available poisons. In New Zealand, rapid knockdown would also facilitate field collection of feral pig carcasses for surveillance for bovine tuberculosis. Previous research suggests that pigs can detect cyanide (probably by smell), so a delivery method for pigs would need to disguise the presence of cyanide. A modified mechanical ejector device (*Fig.*) was developed as a delivery method that could achieve this. Bait or lure is firmly attached to the holder of the capsule, which encourages pigs to pull on it. A pulling force of at least 2 kg is needed to trigger the ejector which then drives a spring-loaded piston through a plastic capsule containing the cyanide powder and ejects the contents into the mouth of the pig. The cyanide powder immediately comes into contact with the moist surfaces in the pig's mouth producing cyanide gas that is lethal when inhaled. This technique has been particularly effective against foxes and wild dogs, achieving rapid kills and enabling collection of carcasses for other purposes. Penny Fisher and Matt Campion tested the efficacy of a prototype ejector device in delivering cyanide to pigs in a small pen trial.

Six domestic pigs were acclimatised to activating ejectors loaded with icing sugar. They were then exposed to ejectors loaded with cyanide powder in capsules and baited with dried meat. Two pigs were killed after their first activation of the toxic ejector, with times to death of c. 32 and 70 minutes. This was longer than expected, especially compared with times reported for cyanide in other species. Three other pigs activated the toxic ejector and displayed early signs of poisoning (retching, salivation or vomiting), but appeared to recover fully within 3 hours. The remaining pig did not activate the toxic ejector, despite having activated non-toxic sets repeatedly.

The three pigs that survived were exposed to an estimated 14–25 mg cyanide/kg bodyweight, indicating they are less susceptible than other mammals to cyanide, e.g. the lethal dose (LD50) estimate for possums is 8.7 mg/kg. This

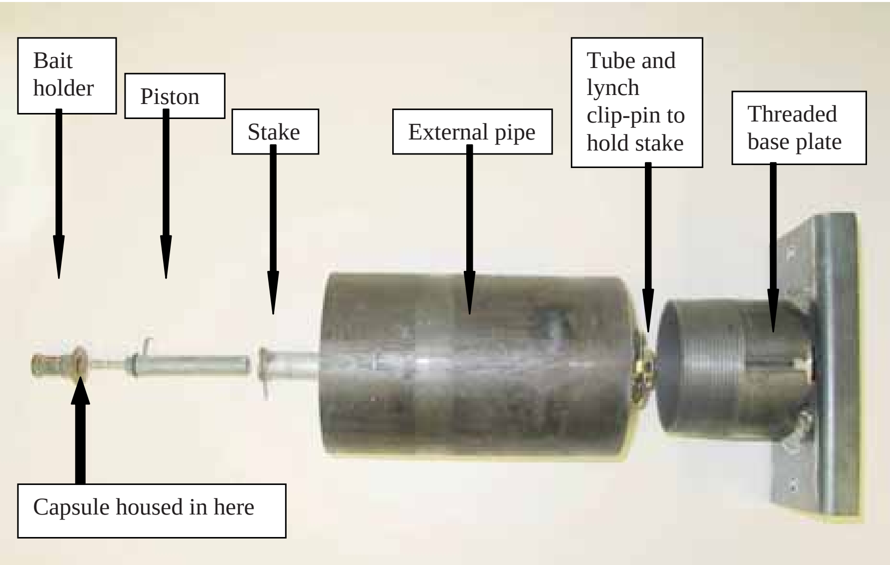


Fig. *Mechanical ejector tested against six domestic pigs*

indicates that higher loadings of cyanide would be needed in a bait formulation that was effective against feral pigs. The relatively slow progression of poisoning in pigs indicates the animal welfare implications of cyanide for pig control need to be re-evaluated. While cyanide may not be suitable as a toxin for feral pigs, the prototype ejector proved to be an effective oral delivery method. It has potential for the delivery of other pesticides for localised, targeted management of pig populations wherever hunting or trapping is impracticable.

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

Penny Fisher
fisherp@landcareresearch.co.nz

Matt Campion
(not shown)

1080 Uptake in Wild Harvested Plants – Watercress and Pūhā

In 2007, the Environmental Risk Management Authority (ERMA) outlined new recommendations in its decision to support the continued use of 1080 to control vertebrate pests in New Zealand. Among these recommendations were issues that required further research – including the effects of the accumulation of 1080 in aquatic plants such as watercress. This issue was raised repeatedly by Māori during the 1080 reassessment process. The uptake and persistence of 1080 in watercress and pūhā, two of the most widely recognised and frequently harvested wild plant food species by Māori, is now being investigated. A collaborative *in situ* experiment with the Lake Waikaremoana Hapū Restoration Trust (Tūai) using pūhā has been completed, in which a 'worst-case' exposure scenario was established where individual plants were exposed to one 12-g cereal bait (0.15% 1080) with leaf samples collected over 38 days after initial exposure. Preliminary results indicate that the 1080 concentration in the foliage reached a maximum of 15 parts per billion after 3 days but had declined to zero after 38 days. A similar experiment using watercress will be carried out in collaboration with Te Rūnanga o Kaikoura and a local Kaikoura farmer. Results from both experiments and what these levels mean to consumers will be presented at hui and included in the 1080 database available on the World-Wide Web (*http://www.lincoln.ac.nz/1080*).

This work is being done under contract to the Animal Health Board.

James Ataria
atariaj@landcareresearch.co.nz

A Weka-Proof Possum Trap

Leghold traps set on the ground are widely used for monitoring the abundance of possums following control operations, but the traps endanger threatened ground birds such as kiwi and weka living within monitored areas. To reduce the risk in areas where there are ground birds, leghold traps are usually placed above the ground on leaning boards or on tree-mounted platforms, although these modifications are generally more labour intensive, catch fewer possums than ground-set traps, and provide less robust estimates of possum abundance. As possible alternatives to the raised traps, Peter Sweetapple and his colleagues designed and tested weka-excluding doors for two commercially available possum kill-traps. They acknowledged that covered kill-traps were likely to have lower catch rates than raised-set leghold traps. However, the daily servicing of leghold traps (as required under the Animal Welfare Act 1999) is not required for kill-traps, and thus extended periods of trapping using covered kill-traps is more likely to be cost-effective.

The 'Sentinel' and 'Set-n-Forget' kill-traps used in this study are supplied with plastic covers that guide possums into the jaws of tree-mounted traps. Peter and his colleagues modified these covers by adding a spring-hinged door that possums need to open to access the trap (*photos a & b*). After showing that penned possums could successfully access the trap, covered traps were tested for their ability to exclude weka. Traps were set in a forested area with abundant weka and weka encounters with traps indicated by their foot prints in mud-filled trays placed under each trap (*photo c*)

In these trials, all weka were successfully excluded during 95 encounters with Sentinel traps and 98 encounters with Set-n-Forget traps.

The final stage of the study compared the possum-capture efficiency of both traps with that of raised leghold traps. The modified Set-n-Forget traps captured few possums; hence they were discarded from the study. Sentinel traps showed higher possum catch rates and were tested further against leghold traps set on leaning boards in two South Island forests with low possum densities (i.e. a 3–4% trap-catch on raised leghold traps). At both sites, Sentinel traps set and unserviced for 10 nights caught similar numbers of possums as raised leghold traps set for 3 nights and serviced daily. In terms of possums caught per day of fieldwork, Sentinel traps with the modified covers appeared to be about twice as efficient as raised leghold traps and therefore show promise as a cost-effective alternative to raised leghold trapping of possums in weka habitat.

a

b

Sentinel possum kill trap equipped with (a) the standard commercial trap cover and (b) a cover fitted with a weka excluder

c

A wild weka investigates a Sentinel trap fitted with an excluder set over a mud tracking-tray

d

A raised leghold trap set on a leaning board

Additional trials are planned to confirm this. The freedom to run kill-traps without daily servicing also makes Sentinel traps an attractive tool for use in controlling low-density possum populations, where low daily catch rates and high labour requirements make leghold trapping less efficient.

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Peter Sweetapple
sweetapplep@landcareresearch.co.nz

Bruce Warburton and Grant Morris
(not shown)

Contacts and Addresses

The lead researchers whose articles appear in this issue of *Kararehe Kino – Vertebrate Pest Research* can be contacted at the following addresses:

Jamie Ataria
Penny Fisher
Catriona MacLeod
Dave Morgan
John Parkes
Peter Sweetapple
Ivor Yockney
Landcare Research
PO Box 40
Lincoln 7640
ph: +64 3 321 9999
fax: +64 3 321 9998

Grant Norbury
Landcare Research
Private Bag 282
Alexandra 9340
ph: +64 3 440 2930
fax: +64 3 440 2931

Richard Duncan
Bio-Protection and Ecology Division
PO Box 84
Lincoln University
Lincoln 7647
ph: +64 3 325 2811 ext 8969
fax: +64 3 325 3864

For further information on research in Landcare Research see our website: http://www.landcareresearch.co.nz

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Editors: Jim Coleman
colemanj@landcareresearch.co.nz
Caroline Thomson
thomsonc@landcareresearch.co.nz

Cartoon: Susan Marks

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