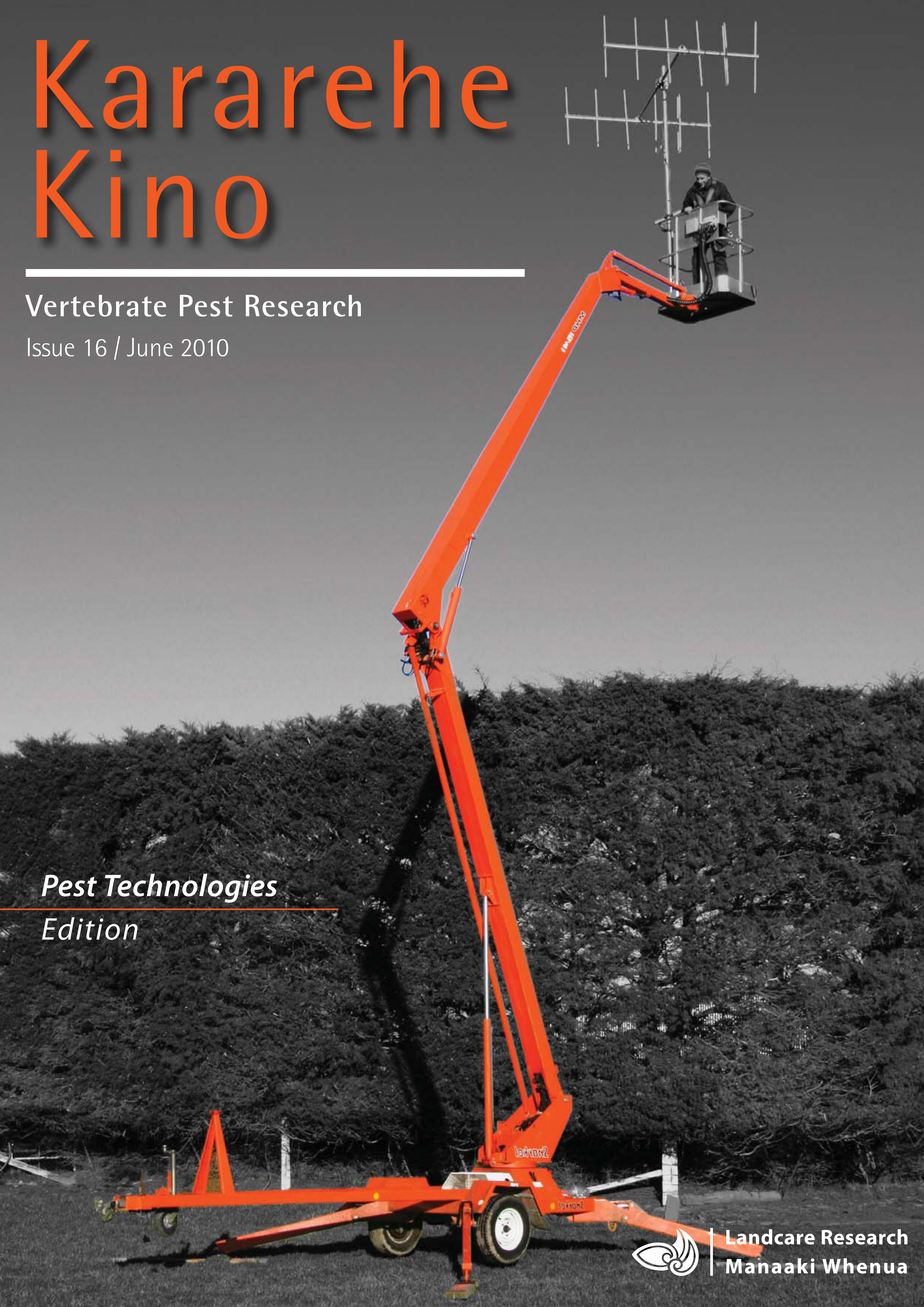
Kararehe Kino

Vertebrate Pest Research

Issue 16 / June 2010



Pest Technologies Edition

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Front cover photo by Kev Drew.
Morgan Coleman using a 'cherry picker' to increase the detection distance of finches equipped with radio transmitters.

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www.landcareresearch.co.nz

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Editorial

This edition of Kararehe Kino highlights some recent technological developments arising from science programmes undertaken by Landcare Research for better management of vertebrate pests.

At the operational level, we describe new tools for understanding the behaviour and presence of pests at feeding sites and killing engines, such as the use of very high frequency (VHF) radio collars integrated with customised receiver base stations, Radio-frequency identification tags (RFIDs) and strategically placed RFID readers, data loggers implanted into large mammals, and strategically placed trail cameras.

At the molecular level, we describe new tests for wildlife diseases, evaluate the use of DNA to estimate animal abundance, and detail some developments of vaccines for fertility control.

The use of modelling to determine the probability of pest eradication is described and contrasts sharply with an evaluation of the ability of trained dogs to capture solitary rodents surviving eradication programmes.

The better use of toxicants remains a core part of our research, and we document alternative toxicants for rodents, a new toxicant delivery system for stoats, and the development of new assay techniques for bait repellents.

Finally, in recognition of the increasing complexity of pest control, a new decision support system (DSS) for pest control is described.

All these technologies are applicable in various circumstances, with various animals, and some are currently being trialled or used to some degree by researchers and pest managers. Most are not mutually exclusive, and may supersede others for particular field uses.

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Jim dissecting a possum in the lab.

Animal Health Board

Issue 16 / June 2010

In this issue...

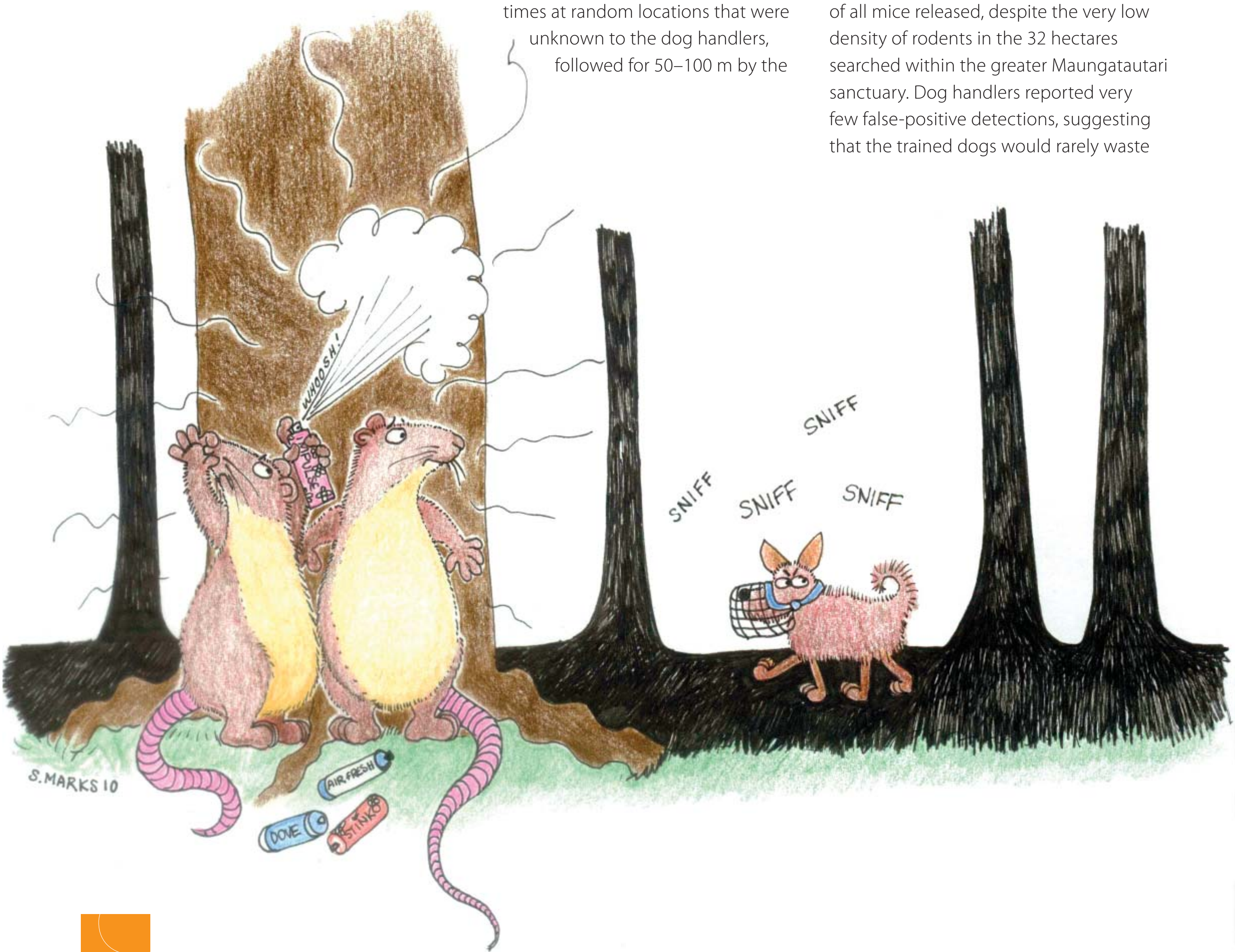
How effective are *trained dogs* at finding single rodents?

To maintain pest-free estate on islands and in fenced mainland sanctuaries, invading individual pests must be detected when or soon after they arrive. To remove the last remaining resident pests in the final stages of an eradication programme, single animals must be detected in largely pest free estate.

Trained dogs are one of the tools available. Dogs and rodents are age-old adversaries, and in a way, dogs exploit one of the few weaknesses of rodents – rodents leave scent wherever they go. Being primarily nocturnal, rodents use scent to mark their movement trails, and such scents tell others whether they are male or female, adult or juvenile, breeding or non-breeding. Rodents always lay a scent trail that, if fresh, a dog can exploit. This means dogs have a potential advantage over traps, tracking tunnels or poison baits – which rodents can choose to enter or not, or eat a lethal bait or not. But how effective are trained dogs at finding single rats and mice? John Innes and colleagues and two experienced rodent-dog teams went to Maungatautari, a fenced pest-free forest sanctuary in the Waikato, to find out.

Radio-tagged laboratory-reared Norway (brown) rats and mice were released 96 times at random locations that were unknown to the dog handlers, followed for 50–100 m by the researchers, then caught and either placed in hidden cages at the end of the scent trail or removed from the forest (Gsell et al. 2010). Two trained and certified rodent dogs and their handlers then had up to 6 hours later the same day to locate the rodent trails and hidden rodents, working the block from opposite ends on search lines 50 m apart. Up to five rodents were released on any one day. The handlers were not allowed to communicate with each other during the trial.

Both dogs were highly successful at finding the scent trails and hidden rodents, together locating 87% of all rats and 80% of all mice released, despite the very low density of rodents in the 32 hectares searched within the greater Maungatautari sanctuary. Dog handlers reported very few false-positive detections, suggesting that the trained dogs would rarely waste



time reacting to indications of rodents that were not in fact present. The two handlers estimated the average distance at which their dogs detected rodents was 66 ± 9 m (range 5–150 m) and 50 ± 5 m (range 4–110 m) respectively, and the greatest distance at which a dog seemed to detect a scent trail or caged rodent was 150 m. The oldest scent detected by a dog was 15 days old, although most scent was undetectable after 2 days.

The most frequent reason why some rodents went undetected was that, by random chance, the start-points (generated by computer) of some rodent trails were close together. In these instances, the dogs indicated rodent presence but did not indicate how many individuals were present at a given location. In real invasion situations, this error would have little consequence, since any single rodent detection will trigger a standard rodent removal response that will effectively target several animals if they are present.

Researchers followed the rodents closely while scent trials were laid and the combination of human and rodent scent may have made it easier for the dogs to find the rodents. However, the researchers frequently walked to parts of the study area for other tasks during the research, and the dogs never indicated or followed these human trails.

The researchers concluded that well-trained rodent dogs and their handlers are likely to be able to locate wild rodents at low densities in forest situations. Each handler and single dog team should be able to cover 30–40 hectares of typical forest in 0.5–1 day, but this will vary greatly with terrain and vegetation. Of course, another technique is then required to actually catch and remove the offending rodents, but dogs can provide some confidence to managers that rodents are present or not.

Neil Fitzgerald

Radio-collared laboratory rat used to lay scent trails to test rodent dogs at Maungatautari, Waikato.

John Innes

Handler Fin Buchanan and trained rodent dog Jak during trials at Maungatautari, Waikato.

Further work is required to compare the cost-effectiveness of dogs with other commonly used detection devices such as baited tracking tunnels and traps, and to see if dogs can find wild ship rats that frequently climb trees or wild mice that often burrow.

The work is funded by the Foundation for Research, Science and Technology, with assistance from Environment Waikato.

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Anna Gsell, Dianne Brunton (Massey University), **Pim de Monchy** (Maungatautari Island Trust) and dog handlers: **Fin Buchanan** and **Miriam Ritchie**

Reference

Gsell A, Innes J, de Monchy P, Brunton D 2010. The success of using trained dogs to locate sparse rodents in pest-free sanctuaries. *Wildlife Research 37*: 39–46.

Implanting data loggers *in wild pigs*


Ivor Yockney

The home range and movement patterns of wild pigs are notoriously difficult to determine, as pigs either destroy or remove radio-tracking collars and harnesses shortly after these are attached. To overcome this problem, Jagath Ekanayake and his colleagues have developed and trialled an implantable GPS data logger that can record 2–24 GPS locations a day for up to a year. These implants are less likely to get damaged than collars and, in theory, could replace external GPS units. The pilot trial involved surgically implanting prototype GPS units at different depths under the skin of pigs to test for differences in the unit's accuracy with the depth of the implant. The pigs were kept in a 1-ha enclosure so their exact location was always known.

A group of captured wild pigs, some of which have been implanted with GPS data loggers (see photograph of implant site at left).

Overall, the pilot trial indicated that GPS units implanted 25 mm or less under the pig's skin are a feasible and reliable alternative to GPS collars. They also have the potential to work on other large mammals. As a result of the above testing, the team will trial and refine the use of GPS implants in wild pigs to be released later this year.

This work was funded by Landcare Research.

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Ivor Yockney, Jackie Whitford

An automatic detection device for small mammals

A new device for continuously recording presence/absence and time spent at specific locations by small mammals carrying implanted radio-frequency identification tags (RFIDs) has been developed and tested by Richard Clayton and his colleagues. The device provides an alternative, improved system compared with traditional very high frequency (VHF) contact loggers. The new tag reader comprises a short length of PVC pipe blocked off at one end and with an encircling aerial at the other (photo). The aerial is attached to a modified RFID reader and data logger, and the system is powered by a small 12-volt battery. Eight rats implanted with RFID tags (manufactured by Allflex®) were observed interacting with the device in purpose-built pens for one night each.

The RFID reader was successful in recording all of the tagged rats entering the pipes and the length of their stay there. However, sometimes the rats approached but did not enter the pipes; these were not recorded, presumably because the detection radius of the reader is insufficient to record animals a short distance away.

The work has been a successful 'proof of concept' trial. Further studies are planned to improve and standardise the device and to develop a model for larger animals, such as possums.

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

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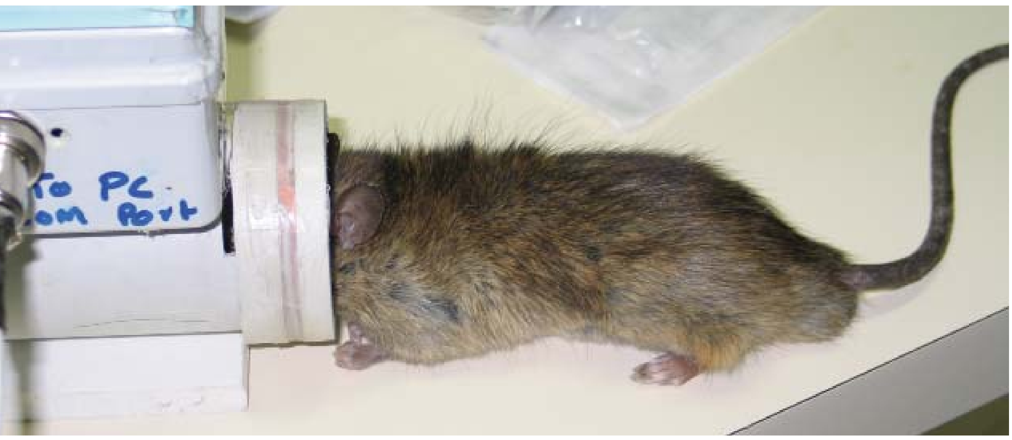
Jagath Ekanayake, Sam Brown



Richard Clayton

A tag reader showing how a rat would trigger the device by entering the PVC pipe.

Detecting the presence of *possums near killing devices*

Ecologists have been collaring possums with very high frequency (VHF) transmitters for several decades, but have never been able to use this technology to automatically detect the presence of possums around possum killing devices (i.e. traps or bait stations). This may change. Bruce Warburton and Geoff Graham (Graham Electronics, Amberley, New Zealand) have developed an integrated scanner and data logger that, when placed out in the field, automatically scans for the unique frequencies of transmitters carried by individual possums living nearby.

Two field systems have now been trialled. The first uses a small whip aerial and records the arrival of a collared possum within a 2–4 m radius of a specific killing device, while the second uses a 350-m length of coaxial cable to record the arrival of possums within 1–5 m of a line of prefeed or toxic bait. The detection range of both systems is not precise but can be controlled by fine tuning the receiver for maximum signal gain: Also, for both systems, the signal strength from the collar depends on the orientation of the animal (and thus the collar) in relation to the aerial. For the coaxial system, the rate of detection increases with decreasing distance to the scanner / data logger. These problems aside, this technology is providing new insights into the behaviour of possums and other vertebrate pests encountering baits or traps, and eventually will allow for the optimal layout of both. The technology also has wider potential, as it will permit ecologists to determine the proximity of any animal species to any object, e.g. its den site or feeding station.

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

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Bruce Warburton

The scanner and data logger in a waterproof box and linked to a solar panel for continuous operation.

Use of trail cameras

Movement- and heat-activated digital trail cameras equipped with rapid triggering (0.2 second) technology are being used by Grant Morriss and colleagues to examine the behaviour of possums, rodents, and livestock encountering baits, traps, tracking tunnels or feeding sites. Each camera has an array of infrared light-emitting diodes (LEDs) that illuminate the subject sufficiently for successful photography but without disturbing the animal species interacting with it. This technology is an improvement on the widely used video-tape cameras, which are more complex to set up and more prone to failure in wet weather. Grant also plans to trial existing low-cost wireless transmission of images to eliminate site visits to download accumulated data. This would extend the usefulness of the modified trail cameras and enable sites cleared of pests to be remotely monitored for reinvasion. Similarly, pest abundance could also be monitored without site visits.

This work was funded by Landcare Research.

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Steve Hough

Trail camera set up to monitor possum activity at a bait station.

New molecular tests for wildlife zoonoses

With infectious diseases likely to affect human health, such as swine flu, dengue fever and drug-resistant tuberculosis, emerging and re-emerging globally at an increasing rate, science is being called upon for preventative solutions. Approximately 80% of new disease-causing agents infecting humans are sourced from wildlife (i.e. are 'zoonoses'). Hence, understanding what diseases occur in wildlife, and the circumstances under which they could potentially impact human health, is the key to such prevention.

Until recently, pre-empting disease emergence from animals has been extremely difficult due to the microscopic nature of the agents concerned and the logistical issues of working with wild animal populations. However, in recent years, molecular diagnostic techniques have revolutionised tools that accurately monitor disease agents in wildlife populations, assess their potential threat to human health, and identify effective pre-emptive management actions if deemed necessary.

Over the past four years, Dan Tompkins and his colleagues have ensured New Zealand has the capability to detect two agents of potential concern to human health in our wildlife populations – Whataroa virus and murine typhus.

Whataroa virus was first detected in 1962 in bird populations around Whataroa in central Westland, and is the only isolated mosquito-borne virus circulating in New Zealand. Even though at least one other mosquito-borne disease (avian malaria) has greatly increased its prevalence in New Zealand in recent decades, no surveillance for Whataroa virus in its wildlife hosts has been carried out for four decades. This is of concern since Whataroa virus may infect humans, possibly causing influenza-like symptoms. Through the application of a polymerase chain reaction (PCR)-based diagnostic test to specifically detect the presence of Whataroa virus RNA, the team have been able to show that the virus is still present in the Whataroa area. Reassuringly, while the virus is apparently persisting in introduced blackbird and song thrush populations, it appears not to have increased substantially in its wildlife hosts. However, Whataroa virus may become an increasing cause for concern to human health if populations of non-native mosquitoes present in New Zealand spread to the area. Non-native species include *Aedes notoscriptus* and *Culex quinquefasciatus*, which are known vectors of related viruses in other countries. Whether spillover infection is already impacting native bird populations is unknown.

Murine typhus is a flea-borne rickesttsial disease of rodents (mainly rats) that can spill over into humans, causing a non-specific illness with fever, headache, myalgia (muscle pain) and a rash. Murine typhus in humans in New Zealand was diagnosed first in the Auckland Region in 1989, where it has occurred at a low incidence ever since. Since 1992, a second cluster of human cases has been recorded on the Coromandel Peninsula. Beginning in 2006, a third cluster has been recorded in and around Hamilton. From these observations have come two potential contrasting hypotheses for the behaviour of this disease in New Zealand – either it is stably endemic in wildlife across several parts of the country, with occasional spillover cases in humans being recognised in different locations at different times, or the infectious agent is spreading to new regions and increasing in incidence. The team have carried out a preliminary investigation of these two hypotheses using a PCR-based diagnostic test to detect the presence of murine typhus DNA in blood samples collected from ship rat populations in both the Hamilton and Coromandel areas. In and around Hamilton, the prevalence of murine typhus infection in rats increased from 26% in May 2008 to 38% in August 2008, before declining to 11% in September 2008. On the Coromandel Peninsula, prevalence decreased from 33% in May 2008 to 7% in August 2008. These preliminary results show that the infectious agent is common in rat populations in both areas, and appears to have reached a seasonal peak on the Coromandel Peninsula before doing so around Hamilton. Although further research is required, understanding the reasons behind these different regional patterns will help the team decide whether human murine typhus cases can be expected to increase in these areas and to spread to other parts of the country in the future.

This work was funded by the Ministry of Research, Science and Technology.

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Dianne Gleeson, Dave Slaney (Institute for Environmental Science and Research), **Diana Prada and John Innes**

Collecting a blood sample from a ship rat for the murine typhus PCR diagnostic test.

Dave Slaney

Improving the detection of *radiotransmitter signals*

Tracking small birds, such as house sparrows and finches, equipped with radiotransmitters over arable cropping land in Canterbury is a tricky business. The signals received by portable Yagi antennae held at ground level are generally poor, even when operators move in tandem with flocks containing collared birds. This is because the transmitters are extremely small and the birds are highly mobile.
To overcome these challenges, Morgan Coleman and Keven Drew recently carried out a pilot trial comparing the effectiveness of a normal ground-based Yagi antennae system located at a fixed site, with a twin Yagi system operated in a 'cherry picker' raised to 17 m above ground level (see front cover). The elevated system gave a six-fold increase in the detectability of 25 radio-collared house sparrows, making it possible to obtain clear directional fixes for birds up to 3 km away, compared to just 500 m for the ground-based system. This improved detectability raised the number of successful fixes per bird, from four to up to 20 over roughly two weeks. By providing more and better data, this new system demonstrated a strong site-tenacity of the birds monitored that was unlikely to have been revealed using the ground-based system.

This work was funded by the Foundation for Arable Research and the Sustainable Farming Fund.

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Kev Drew and Catriona MacLeod

Morgan Coleman

Kev Drew fitting a tailmounted VHF transmitter to a house sparrow.

Remote sensors for kākāpō

Critically endangered kākāpō are nocturnal and forest dwelling, and monitoring their location and movements is difficult. A new technology, involving the hardware for a micro-proximity unit, has been developed by Sirtrack* with software adaptations developed by the Department of Conservation to help in kākāpō management. All 123 surviving free-ranging birds on Codfish Island (Stewart Island) and Anchor Island (Fiordland) now carry a transmitter with a micro-proximity unit that transmits a unique identity (ID) code. Customised receiver base stations, which can detect individual birds up to 10 m away, are situated across known kākāpō habitat. The software logs the bird's ID, and the time, date, and duration of each visit. It is now easy for field staff to download reliable data from each base station each day to reveal which bird visited which site and for how long. The base stations may also double as remote weighing and feeding stations, being activated to release food based on the ID and weight of any visiting bird.

www.sirtrack.com
*Sirtrack is a subsidiary of Landcare Research

Chris Birmingham

Rangi, one of the kākāpō being monitored, having his micro-proximity transmitter attached.

A decision support system for vertebrate pest control

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Deciding how to control vertebrate pests has become increasingly complex over the last 20 years due to new knowledge of pest impacts and control, an increase in the range of products available for pest control, new legislative requirements for pest control agencies, increased public interest in the impacts and control of pests, diversification of the pest control 'industry', and reorganisation of the roles of some of the key participants (Fig.).

In particular, under the Resource Management Act and the NZ Biodiversity Strategy local authorities have been faced with new responsibilities for pest management on private land. Very broadly, this requires local authorities to identify key biodiversity assets, and sustainably manage them. As funds are limited, principally by the number of ratepayers and rate levels, decisions have to be made about which assets to manage and how to do this, and this usually involves pest control. Local authorities currently spend approximately $40 million annually to manage plant and animal pest populations, and have recognised the need for a decision support system (DSS) to improve the transfer of information from researchers to pest managers, to help ensure that the most appropriate control methods are rationally and transparently selected.

This need is being addressed by Dave Morgan and colleagues, who are designing and constructing a web-based DSS, initially focused on improving the control of possums, rodents, and mustelids. The logic of the system was designed by identifying the 'generic' questions that apply when pest managers are considering the most appropriate choice of control method, and using 'yes/no' responses to determine the decision paths followed. Such an approach is intuitively easy to understand, and unambiguous. The questions are focused on the key issues of operational aims, land tenure, farming practice, public and environmental safety, community views and involvement, and landowner views. Consideration of these potential constraints in a logical and systematic way results in a series of recommended options being presented that are then narrowed down by establishing what control methods may have been used previously (as frequently repeated use of most methods results in declining effectiveness), and basing final recommendations on the likely cost of the remaining suggested methods. All recommendations will be linked to best-practice advice that is based largely on Department of Conservation documents, and supplemented by practical guidelines for trapping pest animals published by the National Possum Control Agencies (NPCA). Best-practice advice is, in most cases well supported by New Zealand-based research findings, for which references are given.

The system simulates the decision-making process that an experienced, well-informed pest manager would typically follow. However, the team stresses that the tool is designed to support, not replace, decision-making by pest managers. This is because there is always the possibility that the DSS may not consider every operational constraint that applies to a particular pest control operation in a particular locality. To assist in prioritising proposed operations, the DSS also contains a calculation of 'efficiency' (E), as developed and used by the Department of Conservation:

$$E = (W \times B \times S)/C$$

Where W is a weighting based on the relative value of the biodiversity asset (e.g. a species, population, ecosystem, or locality to be protected) using concepts such as species taxonomic distinctiveness; B is the benefit expected from the management action and can, for example, be expressed as the increase in probability of the asset being secure as a result of the action; S is a measure of the probability of control success; and C is the cost of the action.

Pest managers will therefore have a means of rationally selecting actions with the highest efficiency rankings to get the 'best bangs for bucks' from limited budgets.

The DSS is expected to be fully functional on the Internet by late 2010. While the development was initially driven by the needs of local authorities, the tool will be 'open-access' (i.e. freely available) and it is likely to find use throughout the pest 'sector' as described in the Figure. It is expected that new information from research, field practice and manufacturers will be incorporated on an ongoing basis.

In summary, the DSS will:

- Identify the most appropriate control options in response to proposed operational details and constraints
- Provide transparency/accountability in decision-making by producing a hard-copy summary of the DSS input and output
- Enable prioritisation of pest control operations alongside other biodiversity 'actions' such as fencing or revegetation
- Provide for a consistent approach nationwide amongst pest managers considering all the key constraints when selecting pest control methods
- Present 'best current practice' for all control methods to maximise effectiveness and minimise risks

This work was funded by an Envirolink 'Tools' grant from the Foundation for Research, Science and Technology. The Department of Conservation and National Possum Control Agencies are gratefully acknowledged for generously contributing information to this development.

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Bruce Warburton and Margaret Anderson

STAKEHOLDERS

ALL PARTICIPANTS IN BOXES 1–3

IN ADDITION TO:

- Taxpayers
- Ratepayers
- Farmers
- Landowners
- Forest owners
- Horticulturalists
- Conservation groups
- Recreational hunters
- Game harvesters
- Fur and skin buyers

1

Main legislation for pest control

- Conservation Act
- Resource Management Act
- Biosecurity strategy
- HSNO Act
- ACVM Act
- Wildlife Act

2

Statutory pest management and regulatory agencies

- Local authorities
- DOC
- ERMA
- MAFBNZ
- ACVM
- AHB

3

Providers

- Pest control products industry
- Pest control contractors
- Pest monitoring contractors
- Researchers
- Certifiers
- Educators
- Industry bodies

4

Main pests

- Possums
- Stoats
- Rabbits
- Ferrets
- Rats
- Wallabies
- Mice
- Goats

Fig. *A broad summary of the vertebrate pest control sector in New Zealand. Arrows indicate a chain of action from the principal legislative requirements through to targeting of particular pest species. Stakeholders may have involvement and interests in multiple parts of the sector.*

New assays for bird repellents in possum baits

In 2008, the Department of Conservation aerially sowed 1080 baits over parts of the Arawhata Valley, the Hohonu Range, and near Fox Glacier to control possums and rats. In all three areas, kea had been previously fitted with radiotransmitters. Kea presence was monitored before and after each control operation. In the first two areas, all birds survived the toxic baiting, but near Fox Glacier, 7 of 17 kea carrying transmitters died after eating toxic bait. This prompted the establishment of a collaborative research programme by the Department of Conservation, the Kea Conservation Trust, and the Animal Health Board into safe-guarding kea from 1080 baiting.

Part of the programme has been investigating bird repellents to prevent kea from eating possum baits. Two candidate repellent compounds, anthraquinone and pulegone, have been tested and both have proved to be effective in reducing the consumption of non-toxic baits by captive kea. As part of this work, Lynn Booth and her colleagues validated laboratory methods for detecting the repellents in cereal baits. This work provides quality assurance for ongoing trials using different repellent concentrations in bait, and of repellent stability with bait storage and bait weathering. Extending the testing of the best repellent bait formulation to other native bird species, such as weka, kākā and robins, is planned.

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

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Species-specific TOXICANTS for rats

Neil Fitzgerald

Norbormide (NRB) is a toxin that shows some specificity to rats but which is relatively harmless to other rodents and mammals. It is thought to act on the rat's vascular smooth-muscle cells causing death through vasoconstriction of small blood vessels, but the identity of the receptor(s) to which NRB binds (and hence its specific mode of action) is unknown. Brian Hopkin's most recent research has, however, identified several receptors that appear to be involved in the response of rats to NRB.

Brian's primary focus is now to confirm the identity of the receptor(s) that mediate NRB's lethal activity, and to use this knowledge to design specific cell- and tissue-based assays to evaluate the selective activity in the rat of a range of compounds similar to NRB that he has previously synthesised. Then, with collaborators at Auckland and Padova universities, the team will use novel targeted chemistry to modify any promising compounds to achieve enhanced efficacy and safety, targeting the rat in the first instance. Brian then plans to identify the equivalent receptor(s) in other species to help him develop a suite of species-selective toxins.

Such species-specific products will enhance New Zealand's international reputation in 'eco-restoration', and represents an important paradigm-shift in reducing the risk from large-scale, multi-species control of mammal pests to non-target species.

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

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Mustelid control– can we exploit grooming behaviour to deliver a toxicant?

Grant Morriss

Trapping is currently the main control tool for ferrets and stoats. However, trapping is labour intensive, which limits the size of areas that can be controlled cost-effectively. For ferrets, the efficacy of trapping is also limited by seasonal variation in trappability. Toxic baiting offers potential advantages for increased cost-efficacy of mustelid control over large areas. The only toxic bait formulation registered for ferret control in New Zealand is a diphacinone paste, but to date this has been used only in autumn and winter in relatively small scale operations. While there are no toxic baits currently registered for stoat control, registration of the toxicant PAPP for this purpose is pending.

Toxic baits need to be palatable to the target species. Mustelids are fussy in accepting bait, generally preferring fresh rabbit, which rapidly loses palatability in warmer months. So rather than relying on the often-variable voluntary ingestion of bait, Penny Fisher and her colleagues examined the potential for a targeted toxicant delivery system that exploited grooming behaviour in ferrets.

They investigated a range of sticky compounds to see which would best stick to the fur of captive ferrets and so could be used as a carrier for a toxicant. They also observed the ferrets to identify the parts of their coat they were most likely to groom a sticky carrier from. The best carrier was a mixture of a gel used in rodent glue traps and a palatable meat-based additive, and ferrets spent the most time grooming the carrier from their belly and chest.

The next step was to develop an applicator to deliver the carrier to the belly fur of ferrets as they passed through a tunnel. After trials with a range of spring-based prototypes, a simple adaptation of a bristle brush proved most consistent in depositing a suitable volume of the carrier onto the ferret's belly fur. All the ferrets tested with this bristle-brush tunnel groomed the carrier deposited on their belly fur within 24 hours.

Further research is needed to make this concept a useful addition to the mustelid-control toolbox. A suitable toxicant is one need, which may be provided by PAPP. Information is also needed on the longevity of the carrier–toxin formulation under field conditions.

This work was done under contract to the Animal Health Board as project number R-10679.

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Andrea Airey

Possum fertility control vaccines

The rabies vaccine that is used for wildlife in Europe and North America is delivered in baits (above) and utilises a live recombinant vaccinia virus as a delivery vehicle for the oral vaccine; could a similar approach be used in New Zealand to deliver an oral contraceptive vaccine to possums?

The Pest Control Technologies Team has been reviewing their progress in possum fertility vaccine development, contrasting what has been achieved with what remains to be done. They have established clear proof-of-principle for current fertility-control targets (e.g. Gonadotrophin releasing hormone (GnRH), zona pellucida antigens) working in possums. The dual problems of ensuring vaccine efficacy (both in terms of magnitude and longevity of effect) while maintaining the capacity for oral delivery will require new technology for the vaccine delivery system. The team has been reviewing the pros and cons of using either transmissible or non-transmissible live vaccine vectors (such as recombinant viruses or bacteria, or nematodes) for vaccine delivery. The review will be completed in April, and its recommendations will form the basis of future research directions in fertility vaccine development. This work was funded by the Foundation for Research, Science and Technology.

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Modelling the probability of eradicating *starlings in Western Australia*

Fig. *Area in Western Australia with existing small populations of starlings.*

European starlings have periodically dispersed into Western Australia from Australia's eastern states, and since 1971 have established small populations in the south-east of the State (Fig.). The Government of Western Australia has been attempting to eradicate these populations, as the potential annual losses to grain and other horticultural crops has been estimated at $A21.2 million should the existing starling populations thrive.

An integral part of the eradication programme has been the collection of data on control effort and efficacy, and Dean Anderson is assessing this information to see whether it can be used to develop a probability model of starling eradication. He has developed the modelling framework but has not yet completed analysis of the data.

The eradication programme is currently in the 'hunting phase' in which the starling populations are being reduced using guns and traps. In the not-too-distant future the programme will move into the 'confirmation phase', in which it will seek to confirm the absence of birds.
The probability modelling has four principal objectives for the hunting and confirmation phases:

- To predict the hunting and trapping effort needed to reduce the populations to near zero and to provide managers with feedback on the progress made.
- To provide managers with a quantitative probability of eradication success where starlings are not detected in the confirmation phase. A team of managers and scientists will decide the acceptable threshold level of the probability of eradication, at which point operations will shift from 'search and destroy' to scaled-back monitoring. Dean's model will inform the decision team of when the selected threshold has been achieved.
- To predict the search effort necessary in the confirmation phase to obtain an acceptably high probability of eradication, and to allow managers to predict the effort and money necessary to achieve a high level of confidence in eventual eradication.
- To determine the search effort and its design required to develop a post-eradication surveillance system to detect new incursions of starlings.

The eradication model is based on data collected by field staff on searching and hunting effort, on landscape attributes determined from Geographic Information Systems (GIS), and on radio-telemetry data collected on bird movements. There are many sources of uncertainty in the ability of the field team to observe and kill birds, and these will ultimately influence Dean's ability to quantify the probability of eradication. For instance, the team can never be certain if they have counted an individual bird once or many times. This complication is handled by including in the probability model a spatial sub-model of bird abundance, that incorporates population growth.

A second uncertainty is that the ability of the field teams to observe and kill birds varies with the methods employed (i.e. guns, traps or simple surveillance). This is influenced temporally by changes in bird behaviour over the reproductive season, and by birds becoming more wary and difficult to locate and kill as a consequence of increasing exposure to hunters.

Habitat preferences of starlings vary across the landscape, and this influences the probability that a bird will be present in a particular area. Starlings tend to nest in holes in trees located in swamps, forage in livestock paddocks, and avoid standing crops (swamp photo). Very high frequency (VHF) telemetry data have been collected on the movement of starlings across these landscapes to quantify how they use them.

Starlings feeding on pasture.

The final major source of uncertainty is the probability of new introductions. Genetic studies are underway to identify the likely sources of the current populations. While at present, it is impossible to quantify the probability of an introduction, it is imperative that the model's predictions of eradication success are tested for sensitivity to this uncertainty. As more is learned about the sources of resident birds, the estimated probability of an introduction will become more accurate.

The development of this starling eradication probability model will provide important management and eradication-science benefits. Model predictions will furnish managers with quantitative estimates of how much more effort is needed to achieve eradication and when to declare 'success'. In addition, the complexities involved in this project will advance the quantitative toolbox for addressing eradication questions. For the first time, Dean and his colleagues are being forced to incorporate population dynamics, spatial ecology, detection probabilities and probability theory into a single model. This project is a good stepping stone to similar or more complex eradication problems in the future.

This project was funded by the Western Australia Department of Agriculture and Food.

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Dead trees in a swamp that provide nesting sites for starlings.

Overcoming genetic errors when estimating animal abundance using DNA samples

DNA technology is now routinely used in New Zealand for estimating the abundance of stoats, ship rats, possums, and feral cats. To facilitate such work, Andrea Byrom and Dianne Gleeson have been developing a variety of field- and lab-based methods for extracting DNA from these species. These include methods of sampling DNA non-invasively for identifying animals for use in mark–recapture modelling. Although it is possible to generate large amounts of data from non-invasive sources of DNA, a major challenge when using the technology is overcoming genotyping errors that can lead to incorrect identifications. This occurs particularly when only small amounts of DNA are available (such as when using hair collected from sticky hair tubes to obtain DNA from a few hair follicles).

With PhD student Janine Wright and colleagues from the University of Otago, the USA, and the UK, the researchers investigated how to account for sources of error in such genotype data. One major source of error is the failure of DNA amplification of a portion of a gene (allelic dropout). This has the effect of variations between individuals being missed, because only one allele is detected. If errors go undetected and the genotypes are naively used in mark–recapture models, populations can be significantly overestimated. To avoid this, it is common to reject low-quality samples, but this approach can eliminate large amounts of usable information in the form of partial genotypes. Preferably, these low-quality samples should therefore be retained.

Rather than trying to minimise error by discarding error-prone samples, the researchers modelled allelic dropout in their analysis. Janine and colleagues developed a method based on the augmentation of data from European badger that allowed them to model data from samples that included uncertain genotypes. The researchers are now developing similar methods of dealing with such errors that can be applied to invasive mammals in New Zealand.

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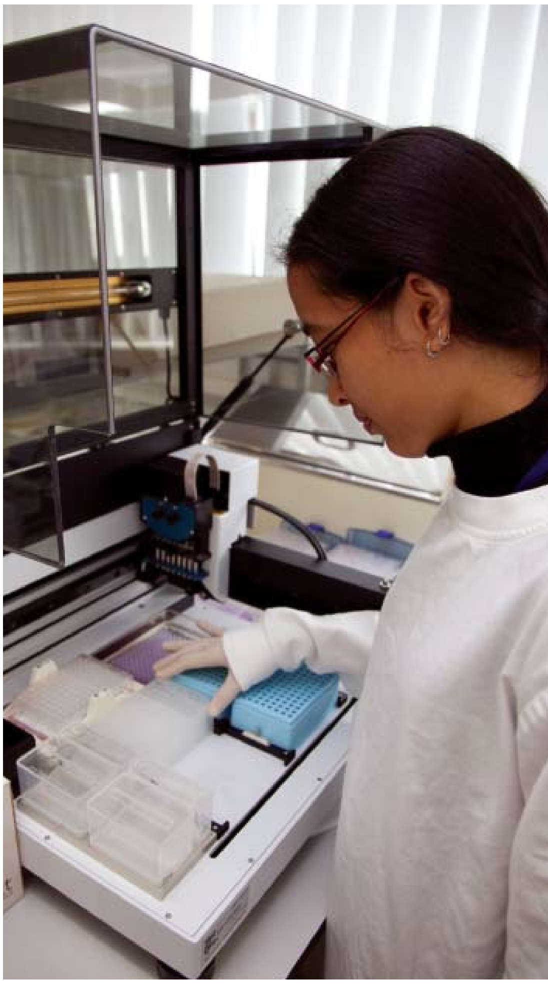

Ecological Genetics Laboratory technician carrying out set-up of polymerase chain reactions.

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