

Kararehe Kino

Vertebrate Pest Research

Issue 24 / June 2014



Engaging Society in Pest Management



Landcare Research
Manaaki Whenua

Photo Credits:

Front cover: Female Mahoenui giant weta translocated into Maungatautari Ecological Island – having a tasty meal of patē safe from predators in her new home! – Danny Thornburrow. (see article page 10)

Pg 3: Jocelyn Neville, Pike Brown, Andrew Macalister, Caroline Thomson.

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Editorial: Importance of engaging society in pest management



Suzie Greenhalgh

Enhancing community engagement in the South Pacific – Adam Daigneault, Pike Brown, and the survey enumeration team in Fiji (mongoose article pages 20–21).

If you've been involved in pest management activities for more than half a decade, the chances are you recognise the importance of public engagement. The involvement of people in all aspects of pest management is vital for a successful outcome, from discussing best-practice pest control to deliberating whether to reintroduce threatened native biota to a fenced sanctuary. The Department of Conservation's recent emphasis on community partnerships is just one example of the growing recognition of the role of society in safeguarding New Zealand's natural heritage for future generations. But what exactly is meant by 'engaging society'? In this issue of *Kararehe Kino*, a series of articles are presented that reflect the many facets of such engagement, and how research can help.

'Crowdsourcing' solutions to intractable research problems is one example of how people can engage with science.

The aim of crowdsourcing (as distinct from 'crowd-funding') is to use a willing online community – sometimes involving thousands or even millions of people around the world – to generate solutions to real-world problems. Visiting Fulbright scholar Becky Niemiec, working with Bruce Warburton and US colleagues, applied this approach in the recent 'Predator-Free NZ' Challenge. Find out what they discovered on page 6. And on the subject of crowd-funding, check out another means of engaging the public in pest management – online games – highlighted by Pen Holland and colleagues from the University of Canterbury on page 8. Pen has been indulging herself in the 'gamification' of science with *Ora*, a game designed to manage a forest ecosystem. The game is complemented by a fun mini game app (*Possum Stomp!*) that you can purchase, which helps fund further development of *Ora*.

As a society, we sanction pest management

activities with a goal in mind, so one important aspect is to discover what people value. Peter Tait and Caroline Saunders from Lincoln University highlight the need to understand how farmers, winegrowers, horticulturalists and foresters value native biodiversity as part of New Zealand's production landscapes (page 15). And in her article starting on page 12, Catriona MacLeod and colleagues from the University of Otago take that concept a step further with their overview of the Sustainability Dashboard – an assessment and reporting tool being developed for monitoring in New Zealand's production landscapes. The Dashboard provides a framework to help understand the role of activities such as pest control in a much wider context, taking into consideration the needs and values of New Zealand society.

The value that society places on New Zealand's 'clean green' image is highlighted by the many facets of community

involvement in pest control activities. On page 10, Colin Campbell-Hunt (University of Otago) and John Innes present some of the late Diane Campbell-Hunt's research on what motivates community groups to get involved with sanctuaries, which are arenas for some of the most intensive pest control for biodiversity conservation. Grant Norbury and Jim Coleman, on pages 18 and 22 respectively, show how science can help communities engage in large-scale pest control operations in natural ecosystems, and how the presence of iconic native fauna can motivate people – including school children, the next generation of pest managers – to stay involved.

Of course, pest management is not without its challenges. It's a field that can generate polarised views, especially when it comes to the use of toxins, or when (in the case of large mammals such as deer and feral pigs) one person's pest is another's recreational or cultural enjoyment. On page 24, Alison Greenaway and Bruce Warburton present Alison's research, working with people who are opposed to the use of 1080. You may be surprised by their findings. Kevin Prime and colleagues discuss the role of Māori values – such as cultural harvest – in the context of pest management on page 23. Finally, as pest management always costs money, obtaining funding is a constant battle for pest managers and researchers alike. In their article on page 20, Pike Brown and colleagues show how the use of financial instruments – incentives to engage the public in pest control – can be used to enhance community engagement in the South Pacific, a location that has its fair share of invasive species problems.

Scientists have a long history of engaging end-users who come with a question, and together develop a solution. This is what applied research should be all about, yet it

still sometimes fails at the final hurdle: using the results in the real world. The uptake of research by pest managers is an issue that generates huge debate and discussion worldwide. Dean Anderson proposes a solution to this problem in his article on page 26, where, with colleagues from Australia, he describes a novel approach to ensure uptake of research findings by pest managers.

As we write this editorial, a final draft of the 'Biological Heritage' National Science Challenge funding proposal is being prepared by researchers from several Crown Research Institutes and universities across New Zealand for submission to the Ministry of Business, Innovation and Employment.

The proposal highlights a very strong emphasis on engaging society in the Challenge; indeed, better engagement with people in order to improve environmental outcomes is one of the top priorities for many of the stakeholders. It also reflects a desire for the research community to work

more collaboratively towards common goals than they have in the past – the variety of institutional affiliations among the authors in this issue is testament to that. We hope that you enjoy this issue, and gain a better understanding of the breadth of our research activities in this growing area.

This article was funded by MBIE contestable projects C09X0909 and by core funding for Crown Research Institutes from the Ministry of Business, Innovation and Employment's Science and Innovation Group.

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John Innes



Pest management research computer game (pages 8–9)

Crowdsourcing for a predator-free New Zealand



Invasive predators such as possums, rats, and stoats pose a serious threat to the survival of New Zealand's native biota. In efforts to protect its native wildlife, New Zealand has coincidentally become a world leader in predator eradication from offshore islands, several of which are now havens for endangered species. On the mainland, predator management is limited to site-based control resulting in mixed outcomes for native biota. After decades of this approach, New Zealanders face the important challenge of determining **how to better control these devastating predators by using their limited resources more creatively.**

Determining the future of predator management in New Zealand requires research that puts greater emphasis on economic and social factors, including the humaneness of control options, the ways in which control is funded, and the ways in which local citizens can be involved. Identifying novel approaches that creatively integrate technological, social, economic, and legal solutions is paramount in increasing the chances of creating a predator-free New Zealand. One strategy to achieve this is to encourage community-led conversations to generate new ideas that could guide future research and management.

Online crowdsourcing to engage people in idea generation is a methodology being used to produce novel and creative ideas that professionals have not come up with. In 2011 Landcare Research used this technique to engage nearly 1000 people in developing 9000 ideas over 24 hours in generating ideas about the Christchurch rebuild: <http://magneticsouth.net.nz/> Recent research led by Rebecca Niemiec and her colleagues, in partnership with the Innovation Challenge Team, Marshall Business School, University of Southern California and the Kenan-Flagler School of Business, University of North Carolina, sought to understand if crowdsourcing could increase diverse citizen engagement to develop novel solutions for predator management. Landcare Research used the online 'Brightideas' platform to run a 13-day crowdsourcing challenge called 'The Predator-Free New Zealand Challenge'. The challenge, which ran from 11 to 23 February 2014 on the website pestchallenge.org, asked participants to post facts, trade-offs, short ideas, questions, and integrative solutions on any of four topics – research and technology, social values, financial incentives, and laws, regulations and policies – related to predator management.

The homepage of the Predator-Free New Zealand Challenge allowed participants to read and respond to others' ideas and post ideas to help make New Zealand Predator-Free by 2040.



Over the course of the Challenge, 258 citizens registered, 99 actively participated by offering their ideas and comments, and 71 filled out the pre-challenge survey, providing information about their perspectives and previous involvement with predator management. The most represented occupations of participants were 'Researcher' (22.5%), 'Student' (9.9%), and 'Farming, Fishing, Horticulture, and Forestry' (8.5%). Participants were highly involved in pest management (70.4% had laid bait or traps for vertebrate pests) and were also highly informed about the negative impacts that pests have on the economy and native ecosystems. Before participating in the entire Challenge process, 52.1% of participants felt strongly that New Zealand should strive to eradicate all pests, 90% strongly believed that some pests at their current population levels were a threat to native birds and plants, and 53.5% strongly believed that unmanaged pests could be a threat to New Zealand's overseas agricultural trade.

The Challenge encouraged discussions on diverse topics relating to predator management with 134 ideas posted and 564 comments generated. The most active discussions included: school education programmes about pests; improved research for biological control and sterilisation

techniques; aerial 1080 use and non-target impacts on native birds; automated species-specific toxin delivery devices; hunter and citizen pest monitoring and control; rolling fronts and cheaper predator-proof fences; and a focus in planning on eradication on offshore islands first. Management of feral and household cats was also discussed in multiple highly commented threads, including possibilities for stricter legislation, desexing, and microchipping.

Initially, Rebecca and her team were concerned that researchers were a primary participant group in the Challenge. However, they discovered that the public wanted an opportunity to engage researchers in conversation – often difficult in face-to-face meetings because of the roles of the participants. However, in a crowdsourcing platform with pseudo-anonymity (the participants have screen names), there can be greater openness to debate issues.

While the posts offered by Challenge participants were not always new, they provided an indication of community values and so are worth considering further. These include: 'backyard' pest monitoring and control; citizen or school programmes that provide citizens with monitoring methodologies; nationwide conversations to

define goals on how to focus management efforts; laws regarding microchipping or desexing of cats or mandatory cat curfews or cats bells; nationwide or tourist levies for predator management or tax breaks for landowners doing their own control; and an initial focus on offshore island eradications and the use of these to learn how to scale-up eradication methodologies to large areas and to showcase what a Predator-Free New Zealand would look like. Currently, ideas from the challenge are being shared with representatives from Department of Conservation, TBfree New Zealand, and community-based pest controllers. Results from the Challenge will continue to be distributed to interested citizens and groups, so please email niemiecr@landcareresearch.co.nz if you would like to receive updates.

This work was funded by the Ministry of Business, Innovation and Employment (C09X1007), the National Science Foundation (Award Id: 1219832), and the James P. Reynolds Foundation at Dartmouth College.

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**Bruce Warburton, Andrea Byrom,
Jennyffer Cruz and Bob Frame**



Making pest management research accessible via computer games



Researchers in all fields of science are increasingly using complex computer models to manipulate very large quantities of data to mimic the real world and assess the consequences of various actions. One characteristic of such models is that they provide a vastly cheaper and faster way of finding the best course of action to solve a problem compared with working in the real world. This is because models have the ability to try multiple strategies simultaneously, and start again from scratch if the selected strategy fails. Pest management to protect New Zealand's biodiversity is a great example of this approach: trying out a range of control strategies ad hoc would not only have serious social, political and economic costs, but could take decades to find out which strategy was the best, by which time the ecosystem itself would have changed.

However, there is little point in researching new pest management technologies and strategies if the public won't accept them. Pen Holland and Bruce Warburton and colleagues at the HITLabNZ (Human Interface Technology Laboratory, University of Canterbury), in conjunction with Driedfrog, a game development company,

have come up with a new way of making the science of pest management available so that anyone can engage with the problem and understand the consequences of invasive pests on forest health. Ora – Save the Forest! is an online, fun-filled ecosystem adventure game based on real-life data and forest-pest-management models.

Are you ready to play?

Inside Ora, players plan and execute campaigns to control pest numbers, monitor ecosystem health or just explore the forest. For every decision that a player makes, there is a budget plus biological, social and regulatory constraints. Players must create strategies using tools that are available in the real world, to try to beat the budget and save the forest – or, if they want to be really perverse, feed the possums and watch them devour the trees. Players' actions earn Science Points that move the 'Hatch O'Meter' closer to hatching a kiwi in the virtual sanctuary, and collect dead possums in a pest storage facility. The first version of Ora will be released later this year.

If Ora sounds too serious for you, then there is Possum Stomp!, a less serious alternative.

This mini-game is unlocked when the Ora storage facility explodes with possum pressure, but as it is so much fun to play, the research team decided to release it as a mobile app on iPhone, iPad and Android.



Possum Stomp!

Stompy the Kiwi is peacefully guarding his nest when marauding zombie possums come out of the forest and try to steal his eggs. The zombies represent invasive pests throughout New Zealand, and they are mercilessly rampaging towards a nest of eggs, representing native biodiversity under attack. Players must help Stompy stomp through multiple waves of zombies on three levels of attack, by day and by night. Successful stomping activates 'power-ups' like the Slow Bomb (lathering zombies in icy-cold goo, slowing them down so that Stompy can squash them flat), or the rain of Decoy Eggs (craved so badly by the oncoming zombies that they forget about the real nest). A big one-footed stomp wipes out all zombies in close range (local eradication), but the ultimate weapon is a two-footed MEGA STOMP – large-scale

eradication that gets players one step closer to an epic win. Possum Stomp is now available via playora.net/possumstomp.

Citizen science and crowdsourcing – the serious side of fun

The Ora and Possum Stomp games are elements of a research programme aimed at developing new technologies for pest control. Ora is designed to make the problem of pest control personal – it's your forest, what do you want to do? The first user studies of Ora were completed in December 2013, and compared the experience of two sets of participants: one group playing Ora, and a control group who worked with the underlying scientific models in a classroom environment. Preliminary analysis suggests that both groups had a more positive perception of pest control 4 weeks post-study, but Ora players retained

more information about pest impacts than classroom participants. After the online release of Ora, players' strategies will be tracked and analysed by Pen and her team, with the data used to help find management solutions to specific problems (levels in the game) as they play and potentially influence future management decisions in the real world.

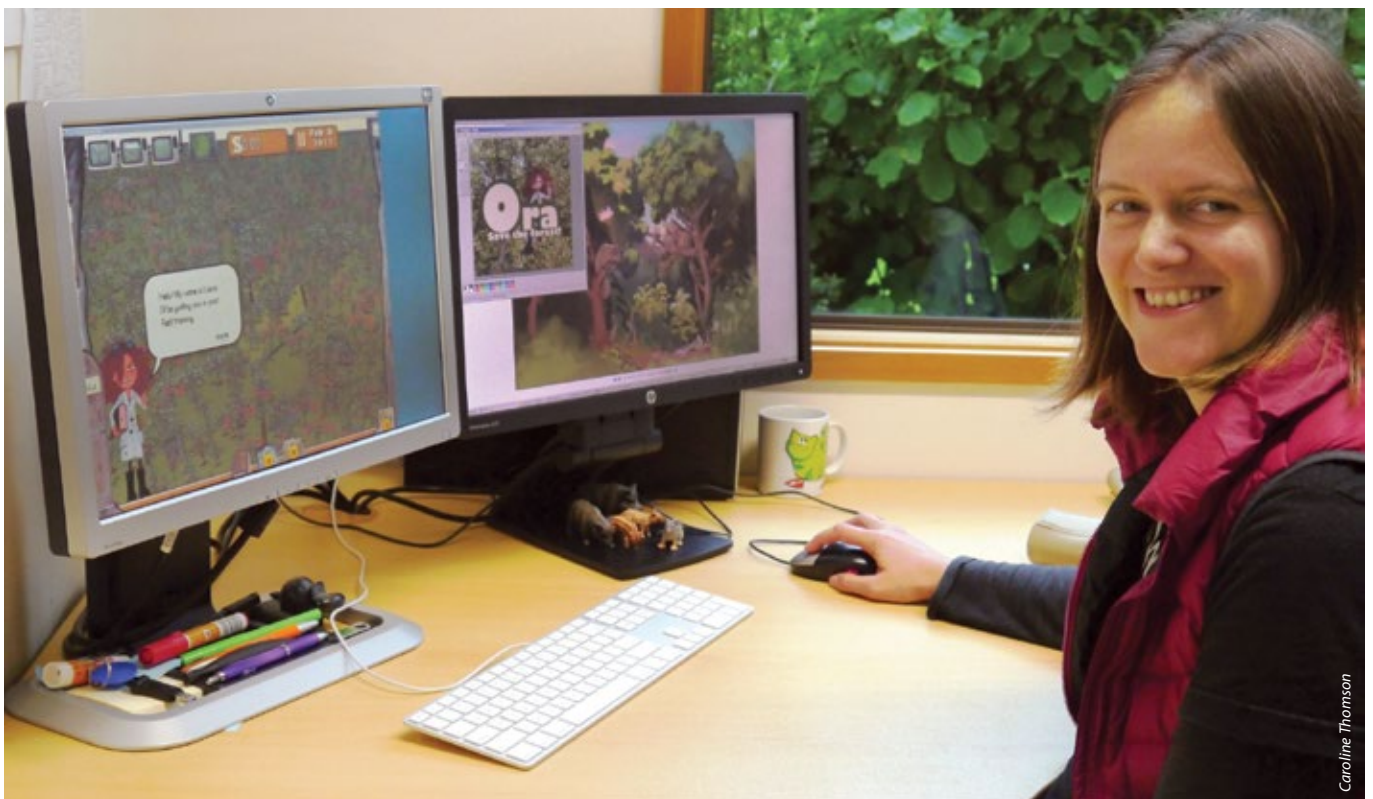
By going to playora.net, you can read more about both Ora and Possum Stomp, follow developments as they happen, and sign up to take part in user tests and be notified when the first release of Ora is available.

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Bruce Warburton and Hazel Bradshaw

(HITLabNZ/Driedfrog)



Pen Holland playing Ora.



What motivates communities to create sanctuaries?



John Innes

Rotokare Sanctuary - a predator-free fenced wetland and forest sanctuary in eastern Taranaki.

In increasing numbers, communities are launching projects aimed at protecting New Zealand's native flora and fauna from the ravages of introduced browsers and predators. Such projects come in many forms: some specific to individual species, others aiming to restore entire ecosystems; some controlling a few predators, others building fences to eliminate them all. For many years, Landcare Research has supported a website and an annual workshop that brings sanctuaries together, and in 2013, Sanctuaries of New Zealand Incorporated (SONZI) was established to help these many initiatives learn from each other.

The Landcare Research sanctuaries database acknowledges 55 sanctuaries totalling 48,000 ha, of which 38 are community-led and total 25,000 ha. In practice, nearly all such projects are cooperative. The mean number of partners in sanctuaries, excluding funders, is 3.2 (range 1–8) and the Department of Conservation (DOC) is a partner in 42 (76%). In total, 42 species have been translocated into 20 community-led sanctuaries, including 31 birds, 6 reptiles, 2 insects, 2 fish and a frog.

These projects are an important new contribution to the conservation cause. So what is driving their establishment? First and foremost, every one of the thousands of people caught up in this movement is

deeply concerned for the future of New Zealand's native species and wants to do something directly and personally to halt their decline and to restore at least some semblance of the way New Zealand was before people came. Many of the founders have close ties to the land, e.g. local landowners and tangata whenua.

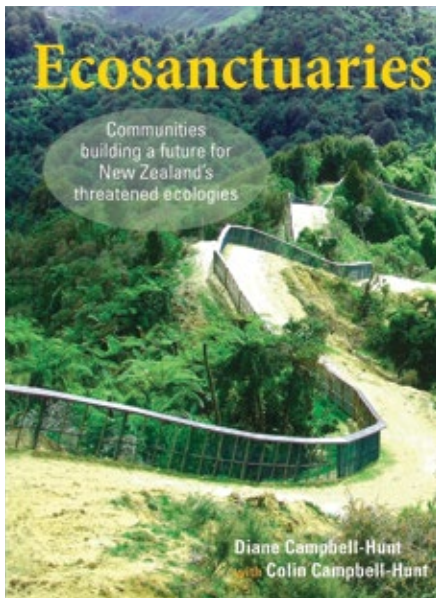
These people are inspired to recreate, even on a small scale and imperfectly, ecosystems

that have vanished from the mainland over the centuries of human habitation. They want to hear New Zealand's birds singing again, to walk through bush where native birds once again thrive, free of imported mammalian mastication and predation. Their greatest hope is to see sanctuaries lead a change in public attitude to conservation such that, in time, the whole country might be free of the worst predators.



Danny Thornburrow

Measuring the hind leg of a Cook Strait giant weta before translocation to Zealandia, a sanctuary in Wellington. Hind leg, pronotum (segment behind head) width and weight of every weta were recorded.



Colin Campbell-Hunt is co-author with his late wife Diane, of 'Ecosanctuaries: Communities building a future for New Zealand's threatened ecologies', Otago University Press, 2013.

You could say that it is local communities that have brought these projects to life. But it is just as true that these projects have been the means for creating communities with a shared commitment to the conservation cause. These groupings have a shared vision to restore what they can of what has been lost, and aim to use the beauty of these lost worlds to advocate for conservation. They want children to experience New Zealand the way it was, to make their native world part of their identity as New Zealanders.

What does it take to get these projects going? Often, it seems that key individuals emerge to galvanise others with their vision and drive. These special people are passionate about conservation but they also have the ability to create a community of supporters that will bring the project to life. There is a social ecology on which the restored natural ecology depends. Evidence of support from the community is usually important in attracting financial support from local councils and trusts, and sustained profile in local media keeps the project in the public's mind.

For a community to come together in this way, it needs to feel a sense of ownership of the project. For larger projects, this can mean the formation of a trust to manage the sanctuary. The people involved in these sanctuaries want to make a direct, personal contribution and to share that contribution with others they come to know as friends: a sanctuary family. Without the freely-given efforts of volunteers, and the financial support of local trusts and memberships, sanctuary projects cannot be sustained. The participation of tangata whenua is of special importance, in part because of the role they play in species translocations.

The belief is that by tapping into these powerful motivations of shared personal commitment, community-led sanctuaries

are bringing resources to the conservation cause that would otherwise lie dormant. The recent repositioning of DOC has explicitly recognised the emergence of community-led sanctuaries and is aiming to forge partnerships with them, seeking perhaps to leverage the limited resources DOC has available to advance the conservation cause.

This work was funded by the Tertiary Education Commission through a Top Achievers PhD scholarship, with additional funding from Landcare Research and the University of Otago.

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Corinne Watts and Danny Thornburrow collecting Mahoenui giant weta from the Mahoenui giant weta scientific reserve for translocation to Maungatautari Ecological Island, April 2012.



Environmental monitoring framework for New Zealand production lands



Clissy Pan

The New Zealand Sustainability Dashboard (NZSD) is a sustainability assessment and reporting tool being developed for the country's primary industry sectors. It recognises that sustainability is a product of good governance that supports and maintains profitable enterprises while encouraging and protecting the environmental integrity of ecosystems and the social well-being of communities. Mitigating pest threats in production landscapes without undermining other sustainability goals is a key challenge for New Zealand.

Here, Catriona MacLeod and the Agricultural Research Group on Sustainability (ARGOS) present a proposed environmental framework (Fig) for assessing sustainable land management of New Zealand's production landscapes. This framework and its indicators are practical, locally grounded and universally accepted. They closely match systems being designed and tested by the United Nations' Food and Agricultural Organisation (Sustainability Assessment of Food and Agriculture Systems) and by the Department of Conservation and regional councils (a coordinated biodiversity monitoring and reporting system).

Guiding and monitoring progress towards the overarching environmental goal

The New Zealand Sustainability Dashboard's environmental framework has an overarching

goal to protect, and where necessary restore, 'agro-environmental integrity' – the state that sustains the full potential of land and its natural capital, ecosystem processes and services to efficiently and indefinitely produce healthy, high quality food and fibre, while enhancing natural heritage values and meeting obligations to global environmental change. The framework recognises the need for an integrated management approach to maintain livelihoods, social well-being and restore ecological integrity; this will require working across a range of spatial scales (e.g. farm, catchment or regional) and governance jurisdictions to deliver the desired management outcomes.

The environmental framework is designed to help guide farmers, industry, local and national policymakers, and the New Zealand public towards achieving agro-environmental integrity. It identifies four critical components that need to be achieved, each defined by a specific set of objectives and indicators (Fig):

1. The natural capital of production landscapes is maintained

Natural capital underpins the production and sustainability of intensive farming in New Zealand. Natural capital stocks include soil quality, availability of nitrogen fixers, and vegetation sufficient to keep the land intact and soils moist. Ecosystem services are the flows of materials (e.g. food and

fibre), energy, regulation benefits (e.g. biological pest controls to replace pesticides) and information (stored in species and ecosystems) from natural capital stocks. To secure or build these stocks and maintain flows of ecosystem services, three objectives are addressed:

- Maintaining ecosystem processes: focusing on soil, water, land cover, ecosystem disruption and pollination
- Reducing agricultural pest threats: considering new and established agricultural diseases, weeds and pests
- Limiting environmental pollutants: assessing risk and persistence of toxins

2. Resilience of New Zealand agriculture is secured for future productive use

Resilience is about learning how to deal with uncertainty and adapt to changing conditions. To support farmers, rural communities, industry, and agricultural economy to build resilient systems for coping with significant challenges posed by new threats (e.g. new diseases), shocks (e.g. increases in the price of fuel) and drivers (e.g. changing market demands) in the future, two key objectives are addressed:



- Minimising material and energy subsidies: considering renewable versus non-renewable use of resources
- Maintaining agro-biodiversity: assessing genetic stocks, beneficial species and ecological refuges in the landscape

3. Production landscapes contribute to national 'natural heritage' goals

A high proportion of New Zealand's species are endemic and both valuable and highly vulnerable. Natural ecosystems in production landscapes are highly fragmented and potentially vulnerable, as are the species within them. Yet such production landscapes occur in lowland, fertile, warm areas, which can support a high abundance and diversity of indigenous biota. Again, pest management can contribute to the overall goal of agro-environmental integrity through helping protect vulnerable species and ecosystems. However, there is limited information available to demonstrate whether biodiversity representation and persistence are improving or not. Three key objectives are addressed to support national 'natural heritage' goals:

- Improving ecosystem representation and composition
- Preventing extinctions and declines
- Reducing conservation pest threats

4. New Zealand meets global environmental change obligations

The United Nations Framework Convention on Climate Change established an international policy for the reduction of greenhouse gas emissions and increases in carbon sinks to address the global challenge of human-induced interference with the climate. Agriculture, which releases significant amounts of greenhouse gases to the atmosphere, is likely to be adversely affected by global warming. Two key objectives are addressed to meet New Zealand's global obligations:

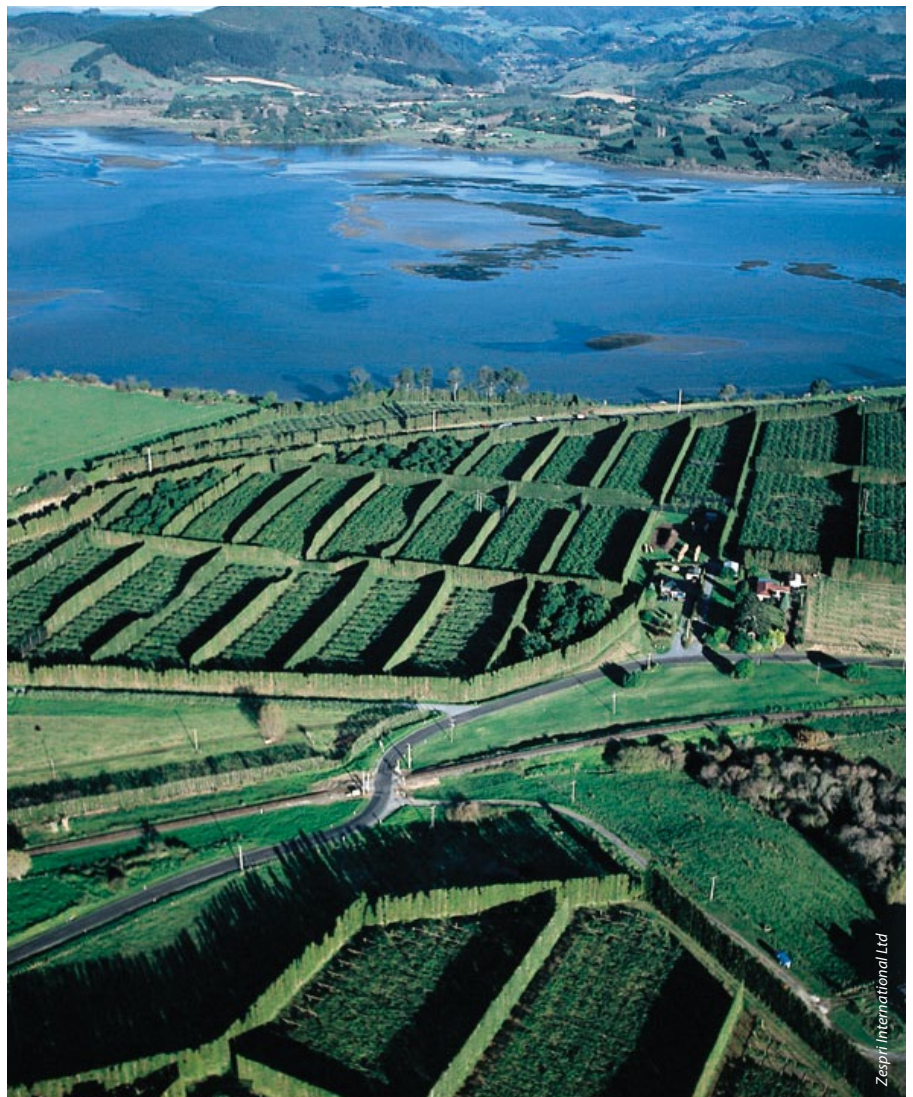
- Reducing greenhouse gas emissions
- Increasing carbon sequestration

Next steps for the Sustainability Dashboard environmental framework

An iterative and interactive process will be used to refine and develop the proposed NZSD environmental framework, to ensure it is both useful and enduring. The NZSD aims to provide a harmonised framework for stakeholders to more clearly define their sustainability goals, outcomes and objectives for New Zealand's production landscapes. Next steps in the development process will

include working with key stakeholders to ensure that the framework:

- is comprehensive (i.e. embraces diverse values and goals) and that the information collected by the environmental framework can be readily integrated with the economic, social and governance components of the NZSD;
- can be readily tailored to meet specific industry needs (initially focusing on developing prototype dashboards for kiwifruit, wine, Ngāi Tahu Ahi Kā Kai and organic farming enterprises);



Kiwifruit orchards in the Bay of Plenty.





OUTCOMES

Critical components for achieving goals

OBJECTIVES

Key factors contributing to targeted national outcomes

INDICATORS

Parameters that can be assessed in relation to an objective

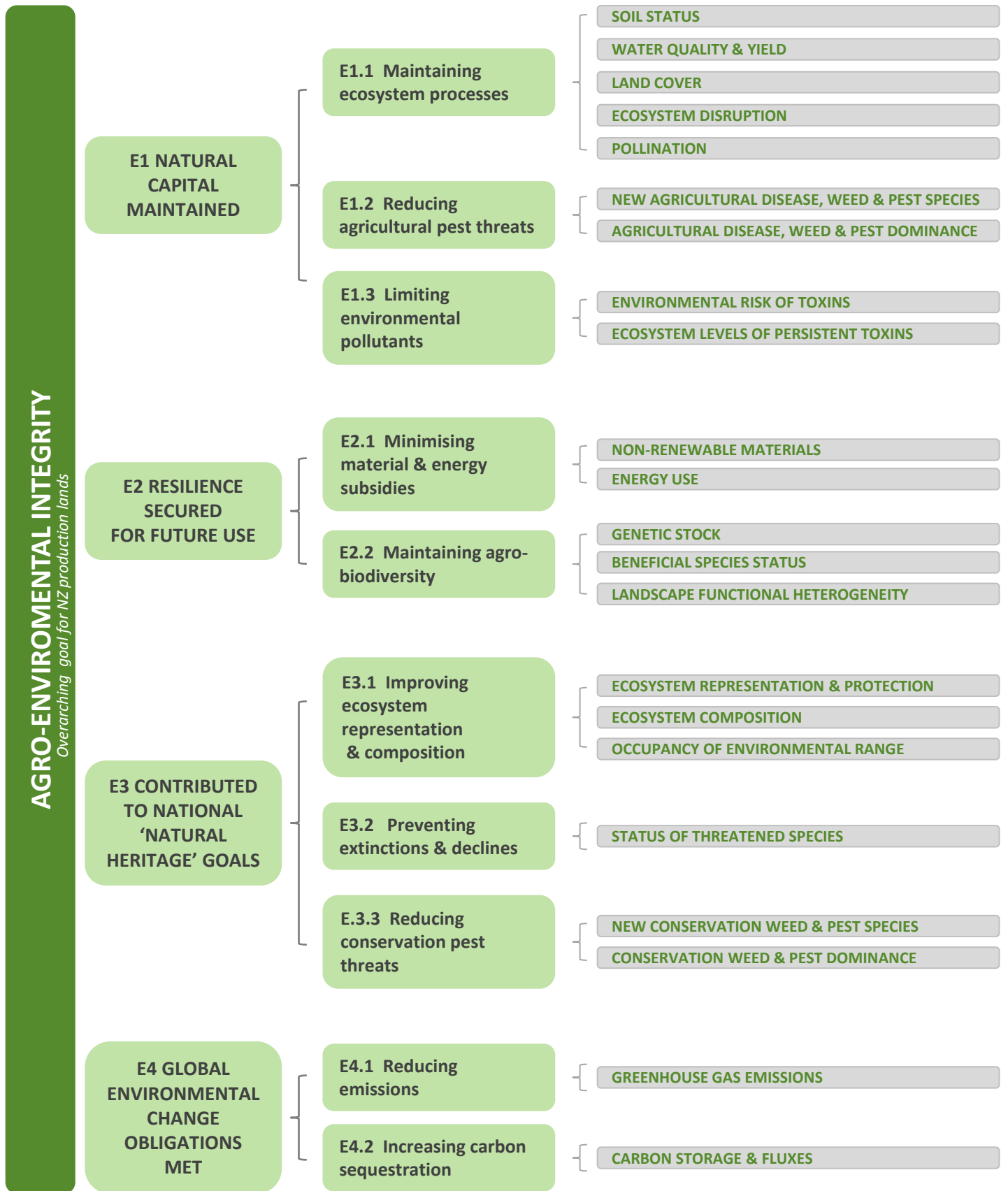


Fig. The New Zealand Sustainability Dashboard's environmental monitoring framework for addressing the 'agro-environmental integrity' goal for the country's production landscapes.

- can connect multiple data layers and key stakeholders to integrate and harmonise monitoring goals and information. This will include integrating information across sectors, landscapes and institutional jurisdictions to make best use of monitoring data and meet multiple reporting needs (regulatory, market access and business improvement); and
- uses a transparent process for prioritising indicators for development and implementation in the prototype NZSD. This will include ensuring that the indicators are derived from information that is not only relevant and practical but also tightly prescribed, rigorously field tested and audited.

With large pest impacts to both the productive and natural heritage components of New Zealand farmland, the costs and benefits of pest management will be an integral part of the NZSD to inform an integrated sustainability assessment and reporting process. This will help guide stakeholders to best practices for New Zealand's society and environment.

The New Zealand Sustainability Dashboard project (www.nzdashboard.org.nz) is funded by the Ministry of Business, Innovation and Employment (AGRB1201).

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Help inform NZSD design – participate in our online surveys

Later this year, we will be inviting feedback on the design of the NZSD's sustainability assessment framework, using online choice modelling surveys.

If you would like to participate in these surveys or help us to coordinate participation within your organisation, please email Isabelle Le Quellec (isabelle@agribusinessgroup.com).

Agricultural Research Group on Sustainability (www.argos.org.nz)

Non-market valuation of New Zealand biodiversity



A native jewelled gecko on a tōtara in Canterbury.

Biodiversity provides significant benefits to New Zealand. Consumers in our export markets value biodiversity as part of the 'clean and green' brand. Likewise, tourists value the 'natural' experience that our native biodiversity provides. To the wider New Zealand public, recreational opportunities and aesthetic benefits are placed alongside the role that native biodiversity has in forming our cultural identity.

The economic value of such biodiversity is difficult to estimate. Some direct benefits,

such as those captured by eco-tourist businesses, can provide estimates of value through market prices. However, many of the benefits that flow from biodiversity are not so readily captured. There are no markets that allow the general public to express their preferences for biodiversity outcomes. Measurement of these benefits therefore requires non-market economic valuation. Peter Tait and Caroline Saunders from the Agribusiness and Economics Research Unit (AERU) at Lincoln University have been working with Graham Nugent and others

at Landcare Research to extend current knowledge of the value of biodiversity to New Zealanders by using choice modelling, a highly quantitative non-market valuation technique.

Choice modelling is used to value goods and services that don't have observable market prices. This approach is appropriate for valuing biodiversity itself or, as is the focus here, for valuing efforts made to protect biodiversity, i.e. because we don't have prices to indicate how much New Zealanders are





Chris Morse

Flowering southern rātā is a spectacular sight for tourists and it is also a major source of honey on the West Coast of the South Island. Rātā benefits from TB-possum control and native birds such as kaka, tui and bellbirds take advantage of its abundant nectar.

willing to pay to save native forests and birds from introduced pests such as possums and rats. Choice modelling has been widely used internationally to value biodiversity but less frequently in New Zealand. In this study, for the first time, we have assessed the value that New Zealanders place on the ancillary benefits to conservation, and to farmers, from the intensive control of possums over about 8 million hectares as part of the national programme managed for bovine tuberculosis. In two separate applications, choice modelling has been used to value, firstly, the wider benefits of TB-possum control to farmers, and secondly, the conservation benefits to the public of TB-possum control in native forest on public land.

Choice modelling is a survey-based method that presents respondents with a series of choice tasks. For each task, respondents choose between at least two options. In this study, the options represent alternative TB-free New Zealand management possibilities. Each option is described by a number of attributes that show possible outcomes for biodiversity or benefits to farmers. In the public survey, biodiversity benefits were described in terms of the degree of protection of canopy trees in native forest, native birds, large native invertebrates, and within-forest plants. For the farmer survey, potential benefits from

TB-possum control were characterised in terms of reduction in damage to pasture, crops, trees and gardens on-farm; reduction in risk of infection, and reduction in threats to native plants, birds and animals both on- and off-farm in Vector Risk Areas (VRAs; the ~40% of New Zealand designated as potentially containing TB-infected wildlife). In each choice task, the levels of each attribute are systematically varied and combined to create a range of management outcomes that are then formed into the choice sets that

respondents face. The underlying economic theory postulates that respondents will choose the options that they think are best for them.

Statistical information derived from these choice tasks is modelled to reveal the relative importance of each attribute. A monetary attribute is deliberately included in each choice set, either as the cost of action required to deliver that particular scenario, or in terms of how much extra (if any) the



Chris Morse

Nationally endangered, the kea was once killed to limit losses of sheep due to concerns by high country sheep farmers. Here, a kea is feeding on Coprosma berries in the Otirā valley, Arthur's Pass.





Caroline Thomson

Possum control reduces the risk of TB spreading from possums to cattle.

respondent would pay for the specified outcome. From these monetary attributes, the monetary value of other attributes can be calculated, and expressed as a 'willingness to pay'. Essentially people are asked how much more they are willing to pay to

have (for example) more native forest with unbrowsed canopy?

An example of a choice set used in the farmer survey is presented below. The 'current management situation' is the same

for all of the five sets presented, and is based on data specific to the VRA or Vector Free Area in which the farm is located. Likewise, the levels of each attribute are defined relative to this situation to construct management alternatives that are relevant to farmers in each area.

Set 1 of 5 **Which of the following management options would you prefer? Select your choice and click on >> below.**

	Current Management Situation	Management Alternative A	Management Alternative B	
Long term (>20yr) TB infection rate per year in your area	1 farm per 1,000	No infections	1 farm per 1,000	
Current TB management levies	Same as now	Increase by one third	Increase by two thirds	
Long term (>20yr) cost of TB testing of livestock	40% less than current testing cost	60% less than current testing cost	50% less than current testing cost	
Presence of possums sighted or heard in VRA farms	Three to four times a year	Once a fortnight	Almost Never	
Possum threat to native plants, birds and animals on and off farm in VRAs	Low threat on farms, improvement in most off-farm bush areas	Substantial damage, increase in threats to pre-1990 levels	Low threat on farms, significant widespread improvement in off-farm bush areas	
Possum damage on farm to pasture, crops, trees and gardens in VRAs	Same as now	20% increase	Slight decrease	
Selection	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="button" value=">>"/>

To date, only the farmer survey has been completed. Six thousand farmers were surveyed via online email in August 2013, and the 1021 responses received appeared to provide a good representation of farm type, size and location. Modelling results demonstrate that farmers derive significant value from the TBfree New Zealand programme over and above the levies they already pay for TB management. Notably, they valued the improved protection of native plants and animals that stem from TB-possum control on- and off-farm in VRAs at c. \$1.5–3.0 million more than current annual levies. Unsurprisingly, farmers valued reductions in infection risk most, at c. \$14–28 million more than current annual levies. The national public survey has now been completed and is currently being analysed.

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Fig. An example of a choice set used in the farmer survey.



Social and biodiversity benefits of predator eradication in a Central Otago community



Publicity around the re-establishment of endangered Otago skinks near Alexandra.

More than a century of burning, clearing and grazing in Central Otago has created dry rabbit-prone ecosystems that bear little resemblance to their pre-European state. Iconic biota has largely vanished or is confined to remnants of indigenous vegetation, while pasture and grape vines dominate the landscape. This has led to a degree of nonchalance among local communities, in an area not especially known for its community focus on biodiversity conservation. In contrast, a group of people, based in Alexandra and Wanaka, concerned about the loss of indigenous species and lack of community involvement in conservation, formed a charitable trust (Central Otago Ecological Trust) in 2005 to rectify this situation. Their mission was to re-establish locally extinct populations of indigenous lizards in an accessible area where people could enjoy them in the wild and be involved in the

restoration process. This work receives tremendous support from the Department of Conservation, who are partners in the project. The trust's first major activity was to organise a public celebration of the return of a threatened species, Otago skinks (obtained from private breeders in the North Island), to the Alexandra area where they were last seen in the 1970s. These skinks were held at the trust's captive breeding facility in preparation for their liberation into a 14-ha predator-free, fenced area on a nearby public reserve.

While the size of this endeavour is small by national standards, it is nevertheless a non-trivial and expensive undertaking. The trust was conscious of ensuring value for money and minimising the risks of biological or financial failure. It therefore spent 3 years undertaking a pilot study in a smaller 0.3-ha fenced area to test the feasibility of re-establishing a wild skink population. Pests

were eradicated inside the fence and 28 captive-bred skinks were introduced in two cohorts 2 years apart. The trust monitored their survival and reproduction, and found it was comparable with that observed for skinks in the wild protected from predators. Part way through the trial, however, mice inadvertently penetrated the fence and began preying on skinks. This was followed by a sharp reduction in skink survival. The trust subsequently eradicated the mice and blocked their potential entry points, and the findings of the trial were formally published to alert other conservation groups to the dangers of mice. These findings modified the trust's planning process for the next stage of its work inside the 14-ha fence, due to be built in 12 months.

The most surprising aspect of the project so far, however, has been the wider benefits to the community that go beyond just



Photos by Grant Norbury

lizards. The project has raised considerable interest in conservation in the district. The trust has 91 active volunteers, 18 foundation members, 29 private donators, 23 corporate donators and 154 people registered for its newsletter. It has also hosted 30 field days for the general public and 20 visits by schools, scout groups, University of the Third Age, Forest & Bird and ecotourism companies. Ten to 20 people usually attend field days from as far away as Dunedin and Wanaka. Television, radio and newspaper interviews are a regular activity. The trust has given 30 invited talks to schools and community groups. The Alexandra Museum has a public display of live Otago skinks donated by the trust and a model skink is now displayed on the entrance sign to the museum on the main street (*photo*).

The project has also inspired a range of artwork, including skink paintings by

Rebecca Gilmore and Alan Waters, sculptures by Jenny Knowles (*see photos*), a children's book by Pam Chapman, poetry by Shirley Grave in her book *The Grasshopper: poems, limericks & children's verse*, and adornment of Escape Rentals vans with imagery of Otago skinks (*photo*).

What has been even more encouraging for the trust is to see the local community celebrating indigenous species by constructing a skink float for the 2008 Alexandra Blossom Festival (*photo*). This was quite an achievement given the community's traditional focus on celebrating introduced species, such as the Alexandra Thyme Festival and the Easter Bunny Hunt.

The trust's success has been recognised by being chosen as the 2010 regional winner of the Heritage and Environment Category Trustpower Community Award for Central

Otago, the 2010 winner of the Inland Otago Conservation Award, and the 2012 overall winner of the Trustpower Community Award for Central Otago.

The extent and breadth of social engagement with what began as a simple lizard conservation project has come as a pleasant but unexpected surprise to trust members. To see people, from very young to very old, developing genuine interest and enthusiasm for conservation in Central Otago is perhaps the most gratifying. People have an innate yearning to see wildlife in their natural state – communities only have to provide opportunities for people to get involved.

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Economic instruments for management of mongooses in Fiji

The small Indian mongoose was first introduced into Fiji in 1883 to control rats in sugar cane fields and is now established on 13 of Fiji's approximately 332 islands, including Viti Levu (1,038,700 ha), Vanua Levu (554,500 ha), and 11 small islands ranging in size from 6.9 to 17 ha.

Mongoose are agile predators: in addition to rodents, they feed on reptiles, frogs, birds, invertebrates, and eggs. In Fiji alone, this invasive species has been implicated in the extinction or decline of barred-winged rail, Pacific black duck, banded rail, purple swamp-hen, white-browed rail, sooty rail, friendly ground dove, black emo skink, and Gibbons' emo skink, ensuring its place among IUCN's 100 worst invasive species. Mongooses also feed on fruit and vegetable matter – including crops – with at least 15% of their diet derived from these sources. In addition, mongooses are carriers of leptospirosis.

For these reasons, control of mongooses on the islands of Fiji and elsewhere has been under investigation since the 1950s. While bounties and trapping have been unsuccessful on islands larger than 115 ha, the species has been eradicated from at least

six small islands via trapping and secondary poisoning. Nevertheless, the costs and benefits of such management are poorly understood.

Pike Brown, Adam Daigneault and Suzie Greenhalgh recently partnered with the University of the South Pacific (USP) and Pacific Invasives International (PII) to conduct cost-benefit analyses of mongoose control on Viti Levu, focusing explicitly on impacts that may be monetised. In total, 360 households in 30 indigenous Fijian villages were surveyed to quantify the value of livestock and fruit crops lost to mongooses and the time and money spent managing them. Results of the survey indicate that households that regularly keep chickens lose on average 6.5 per year to mongooses. Villagers in some areas also report that

mongooses attack ripening fruit and vegetables.

In addition, respondents were asked the extent to which they agreed with a series of value statements pertaining to mongooses, e.g. 'I would like to have more small Indian mongooses in this area'. Eighty percent of survey respondents viewed mongooses negatively, and 13% viewed them neutrally.

Despite the fact that respondents hold overwhelmingly negative views and that most villages report economic losses from mongooses, few survey respondents attempt to reduce the mongoose population. On average, households spend just 3.2 minutes per week trapping or hunting mongooses, and just 2% of households spend an hour or more per week on trapping or shooting. In

Table. Benefit-cost analysis of managing mongooses in eastern Viti Levu (million FJD).

Option	Present value of costs	Present value of benefits	Net present value	Benefit-cost ratio
Do nothing	\$0.0	\$0.0	\$0.0	1.0
Live traps	-\$28.4	\$37.8	\$9.4	1.3
Kill traps	-\$29.6	\$43.1	\$13.5	1.4
Shooting	-\$15.2	\$28.1	\$12.9	1.9

Notes: Discount rate = 8%, project length = 50 years.



contrast, the average surveyed household allocates 3.7 hours per week to managing the invasive African tulip tree.

For the purpose of their cost-benefit analyses, Pike, Adam and Suzie considered four distinct options for managing mongooses: doing nothing, live trapping, kill trapping, and shooting. The costs associated with each management practice were derived from surveys conducted by the Fiji Ministry of Primary Industries. The effectiveness of each option was evaluated by colleagues at Landcare Research, PII, USP, and the Fiji Ministry of Fisheries and Forests. The team assumed a project length of 50 years and a discount rate of 8% – the median used for long-term environmental projects in the Pacific. Finally, the population of mongooses was assumed to follow a logistical growth curve, with the current population assumed to have already reached carrying capacity of 10 per hectare.

Cost-benefit analysis revealed that kill trapping using the DOC 250 trap is more cost effective than live trapping or shooting on a per hectare basis (*Table*). Indeed, given that about 6% of eastern Viti Levu's 411,000 ha of land is currently under cultivation and the crops are at risk from attack by mongooses, the value of using kill trapping to manage mongoose is at least \$FJD13.5 million over the next 50 years. However, kill trapping also entails comparatively high capital costs, and with its modest capital costs and high benefit-to-cost ratio, shooting is an attractive and less expensive alternative to kill trapping. Live trapping is less effective than kill trapping and less efficient than shooting, making it the third-best option. Nevertheless, all three management options are much more cost effective than doing nothing. Finally, these findings are robust to a range of assumptions regarding initial population, management effectiveness, and discount rates, and underscore the value of control.



Suzie Greenhalgh translating survey forms with Jale Tauraga, Fiji Ministry of Fisheries and Forests.

This work was performed with financial support from the seven members of the Critical Ecosystem Partnership Fund, namely, L'Agence Française de Développement, Conservation International, the European Union, the Global Environment Facility, the Government of Japan, The John D. and

Catherine T. MacArthur Foundation, and the World Bank.

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Conducting the household survey in Nataleira village, Fiji.



Community input into a sanctuary in Abel Tasman National Park

Andrew Macalister

Coastal Abel Tasman National Park showing dying wilding pine on the hillside.

Restoration projects in New Zealand come in many forms. They are considered to constitute sanctuaries when they involve the control or eradication of mammal pests to restore indigenous ecosystems and populations of indigenous species. Sixty-three such sanctuaries were identified in 2012 (see Innes & Watts, *Kararehe Kino* 20). Many of them have been established in the last decade and are partly or wholly managed by teams of volunteer workers, a significant shift in pest control away from professional pest managers.

One such sanctuary, managed by the Abel Tasman Birdsong Trust (ATBST), reflects the role played by many community-based teams involved in restoration programmes. It is centred on the southern end of Abel Tasman National Park and the contiguous Perrine Moncrieff private scenic reserve. This charitable organisation, run by trustees and supported by a team of 40+ volunteers (including school children), is a partnership between commercial organisations providing recreational activities in the park and the adjacent marine reserve, the Department of Conservation (DOC), and the local community. The trust uses private sector monies, including those from all major tourism operators in the park (who contribute a 'birdsong' fee based on visitor numbers) to enhance biodiversity values, particularly of native birds and flora and to enhance the enjoyment of visitors to the Park. ATBST operates under a management agreement with DOC and alongside Project Janszoon, another privately funded trust working in the park. ATBST's work is strongly supported by DOC who sees the ATBST programme as extending and enhancing its own programmes through work its staff are unable to undertake under current conservation funding.

Two core projects underpin the ATBST programme for 2010–15: the trapping of introduced predators to reduce the likelihood of them reaching Adele, an island of 80 ha c. 800 m from the mainland and recently cleared of predators, and the clearance of wilding pines from the entire park.

The predator trapping programme involves the fortnightly checking of 80 stoat/rat traps and a smaller number of possum traps, along the southern quarter of the coastal walking track, one of New Zealand's 'Great Walks'. It also involves the quarterly checking of 20 trapping stations and tracking tunnels on Adele Island. The programme is currently being expanded with a doubling of the overall number of traps by installing new trap lines further into the forest to enhance the effectiveness of the coastal trapping programme. To date, around 1100 rats, 130 stoats and 90 possums have been killed, but two stoats and one rat have got across to Adele Island before being trapped and killed there.

The clearance of wilding pines aims to enhance the native biodiversity of Abel Tasman National Park and is undertaken by commercial contractors paid mainly from funds won by ATBST from the National Lotteries Commission. All wilding pines identified through aerial photography across the park are referenced using GPS to enable contractors to locate, drill and poison them. Pine trees along the main walking tracks are cut down by DOC rather than poisoned to eliminate the public hazard created by standing decaying trees. This winter, contractors and DOC will complete the poisoning and felling of wilding pines throughout all of Abel Tasman National Park. Surviving seedlings will be identified and

poisoned in 4–6 years' time when they will have overtopped the gorse and bracken but before any coning takes place. Poisoned pines are an obvious feature on many of the hillsides in the park (see photo) but the first trees treated are quickly disappearing into the surrounding forest.

Lesser programmes undertaken by ATBST include ongoing annual surveys of native birds along the southern reaches of the coastal track and on Adele Island, a survey of the lizard population on Adele Island, and the replanting of clearances along the coastal track with 3500 trees and shrubs native to the park. Past and planned involvement directly with DOC includes the reintroduction of South Island robins onto Adele Island in 2009 and the release of saddleback there within 2–3 years. The release of robins has resulted in a healthy breeding population on Adele Island (and nearby Fisherman's Island), and the release of further robins using birds trapped on Adele Island is planned for 2014–15 on a mainland promontory favoured by park visitors and currently being cleared of predators. Perhaps fortuitously, the mainland trapping programme has coincided with weka and banded rail being seen for the first time in many years in the southern end of the Park.

The results of all of this work are detailed in the ATBST website – www.abeltasmanbirdsong.co.nz – as well as on billboards scattered throughout Abel Tasman National Park. Volunteers working in the park are readily identified by their jackets marked with distinctive trust logos and provide another ready source of information for visitors who encounter them.

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Cultural control of possums

About 15 years ago I was asked 'How would ancient (pre-European) Māori have addressed the possum problem in a culturally appropriate manner if possums had co-existed with them?' My views have not changed. The answer is simple. Māori would not have seen excessive possum numbers as a problem at all. Instead the possum would have been considered an extremely valuable resource in many ways.

As a priority, possum skins with the fur attached would have been used to make kākahu (cloaks) and warm clothing. If possums were plentiful, the furs would also have been made into high quality mats and blankets. The skins would likely have been cut into continuous strips to make a type of string and thread for sewing and korowai (clothing and cloaks). Furthermore, if this thread were plaited, it would have been used to make medium strength ropes and fishing lines. If such rope (with a length of muka fibre as the central core) were re-plaited a really strong and durable multi-purpose rope would have been possible.

Possum long bones would have been used for needles and the vertebrae used for necklaces and knucklebone games.

Possum flesh would have been cooked in many creative ways including grilling on hot stones, being boiled with tikouka, nikau, pūhā, poroporo, parataniwha stalks or kōrau shoots, cooked in a hangi, barbecued over hot coals, smoked, or preserved (huahua) through drying and preserving in its own fat.

Possum offal (intestines, stomach, liver, heart, lungs, and kidneys) would have been classed as 'status delicacies' and consumed at large hākari (feasts). The head (eyes, brains, and tongue) would have been accorded the status of highly prized treats and eaten only by the chiefs (rangatira), tohunga (priests) and high ranking visitors.

Thus, ancient Māori would have made full use of the resource, but how would they



Tane Mahuta (God of the Forests and Birds) represented in the foyer entrance carvings at Landcare Research, Lincoln carved by Ngai Tahu master carver George Edwards assisted by Wiremu Gray and David Johns.

have specifically addressed a population explosion of possums and the consequential depletion of many of the forest species critical to their hunter-gatherer lifestyle? In my opinion local chiefs would have:

- Held competitions to determine who could catch the most possums over a given period, with:
 - The winner made the chief advisor (tohu rangatira, symbol of leadership) because of his ability to provide food in abundance;
 - Such hunters accorded the status of 'tohunga whai kai' (expert hunter) and able to marry as many wives as desired;
 - Stories told and retold of the prowess of hunters able to catch 250 possums (or some other high number) in one night;
 - His skills, knowledge and expertise sought-after by many aspirants to fame and fortune,
- Decried possum hearts (or livers, kidneys, eyes, or brains) the most highly prized food at any hākari, so any rangatira who could provide 3000 (say) such delicacies at a single hākari (feast) would be the envy of every other tribe in the country for generations,
- Encouraged adults to design ingenious traps to catch possums,

- Arranged for children to be taught competitive 'games' of climbing trees and catching as many possums as they could in the daytime,
 - Part of this 'game' would involve:
 - ✓ Skinning a possum (including drying, treating and colouring the skin using hīnau bark);
 - ✓ Gutting a possum (including cleaning and separating the various organs);
 - ✓ Preparing possums for eating;
 - ✓ Cooking: smoking, hangi, huahua (drying and preserving in fat), and tunutunu (barbecue on hot coals).

Most importantly, if possum numbers fell to an unsustainable level, a chief would impose a rāhui (temporary hunting ban), to allow possum numbers to recover before further hunting was allowed.

In my view such a cultural approach to killing possums, complete with variants to accommodate modern-day living (e.g. only one wife per hunter) is a preferable option in easily accessible habitat to controlling them with sodium fluoroacetate (1080), brodifacoum, cyanide or any other forms of indiscriminate killing to waste. Is it worth a try?

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Communities, agencies and 1080

Pathways for New Zealanders to engage in decision making for pest management are currently quite limited. Diverse public interests are expressed via activities such as making submissions on pest management plans, attending public meetings about upcoming 1080 operations, protesting about the use of 1080, helping with ground control, and monitoring the impacts of pest control. Some people seeking to engage with pest control decision-making find these avenues inaccessible, non-inclusive and ineffective. While community engagements can lead to increased consensus around pest control, this is difficult to achieve. In New Zealand successful engagement processes are rare, usually small scale, and often lack adequate resourcing.

A team from Landcare Research, led by Alison Greenaway, are investigating the capabilities for enhanced community engagement in pest control decision-making. In a literature review undertaken in 2011, Alison found that controversies around pest control in New Zealand appear to be relatively well understood. The concerns stakeholders have about different control methods are well and consistently documented. However, despite having some understanding of each other's positions, different stakeholders often do not accept others' positions as valid.

Resourcing for effective community processes, in terms of people's time, costs and skill levels, are high, as they require ongoing engagement rather than staccato bursts at decision-making moments. In addition, engagement is usually done at a small, community scale, and therefore, while the outcomes of the process may be highly successful, they are very limited in terms of the number of people affected. Added to this is the need for effective engagement to involve a degree of flexibility on the part of the agency managing the process, as the sought-after outcomes can conflict with the agency's own culture and its actual or perceived remit. In addition,

different stakeholders have different ways of describing engagement, participation, consultation, or dialogue, and their different uses of language can be confusing and hinder attempts at working across and between different groups.

Participation is influenced by the interplay of relationships, issues, interests and environmental pressures. Also, there are many simultaneous interventions influencing site-based decisions. So the challenge is to position pest control decision-making practices amid all these other interests and activities shaping communities and places. Accordingly, Alison and her colleagues are working with individuals and organisations to try to enhance pest control decision-making as it happens, across scales and localities. One of the localities they are working in is Westland where there is a long history of discontent about the use of 1080. Between April 2013 and December 2013 the researchers undertook 29 semi-structured interviews involving people who live or work near Kumara or were known to be actively concerned about the use of aerial 1080 in Westland. Seventeen of these people also agreed to participate in an exercise mapping their perceived risks (identified by placing tokens on a map) from pests (*Fig. 1*) and pest management (*Fig. 2*).

In January 2014, some of the people interviewed were invited to a workshop in Hokitika where a range of objectives were investigated. For the researchers, the intention was to share findings and possibilities for enhanced engagements with people who were highly concerned about the use of 1080, and to discuss the science underpinning its use in New Zealand. Participants discussed specific questions raised in the earlier interviews including how bovine tuberculosis (TB) is detected, what TB testing methods are used in Westland, the impacts of 1080 on people, society & wildlife, and ideas for enhanced decision making. The ultimate purpose of the workshop was to create a unique forum for people with a

diversity of perspectives, especially around the use of 1080, to meet and attempt to generate points of common interest.

The workshop generated three key ideas, which Alison and her colleagues will explore through a variety of avenues in 2014:

- Formalising a 'watchdog group' of community members that has some defined accountabilities and mandates. A likely outcome of the group could be a report each year for the media and key government agencies on whether local 1080 operations achieved their objectives and on other operational issues community members noticed.
- Supporting an independent citizen-science panel or jury comprised of citizens with a range of interests and concerns regarding pest control. Through meetings, fact-finding missions and workshops, this jury could come up with a checklist of questions, conditions, and targets for pest control operations in Westland. Thus, operations would be reviewed by independent panels of citizens in addition to current regulated procedures.
- Participatory planning of ground control. Currently, only landowners located within or adjacent to pest control operations are consulted when determining buffer zones around towns and water supplies. However, a series of public workshops could be planned in which the wider community could be invited to participate in assigning buffer zones to operations based on ground control instead of aerial control.

This work was funded by the Ministry of Business, Innovation and Employment (C09X1007).

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Rebecca Niemiec and Bruce Warburton

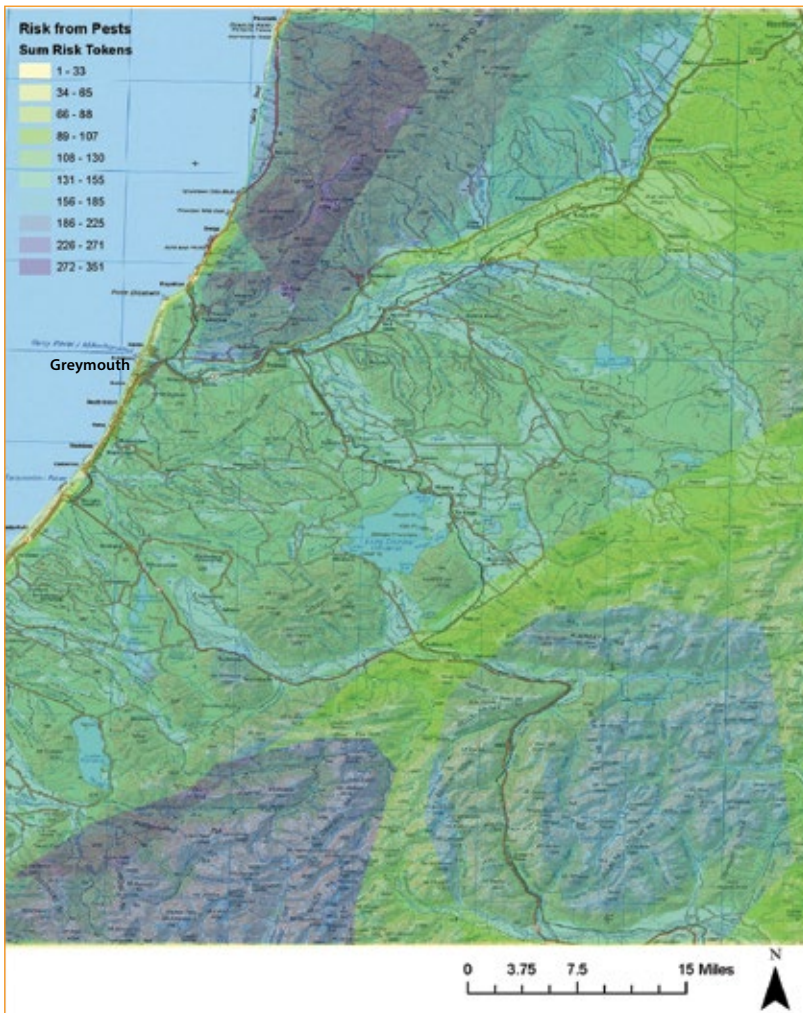


Fig. 1 Citizens' perceived risk from pests to ecosystems throughout the Hokitika and Kumara areas (based on assigned risk 'tokens' attributed by interviewees to areas threatened by pests).

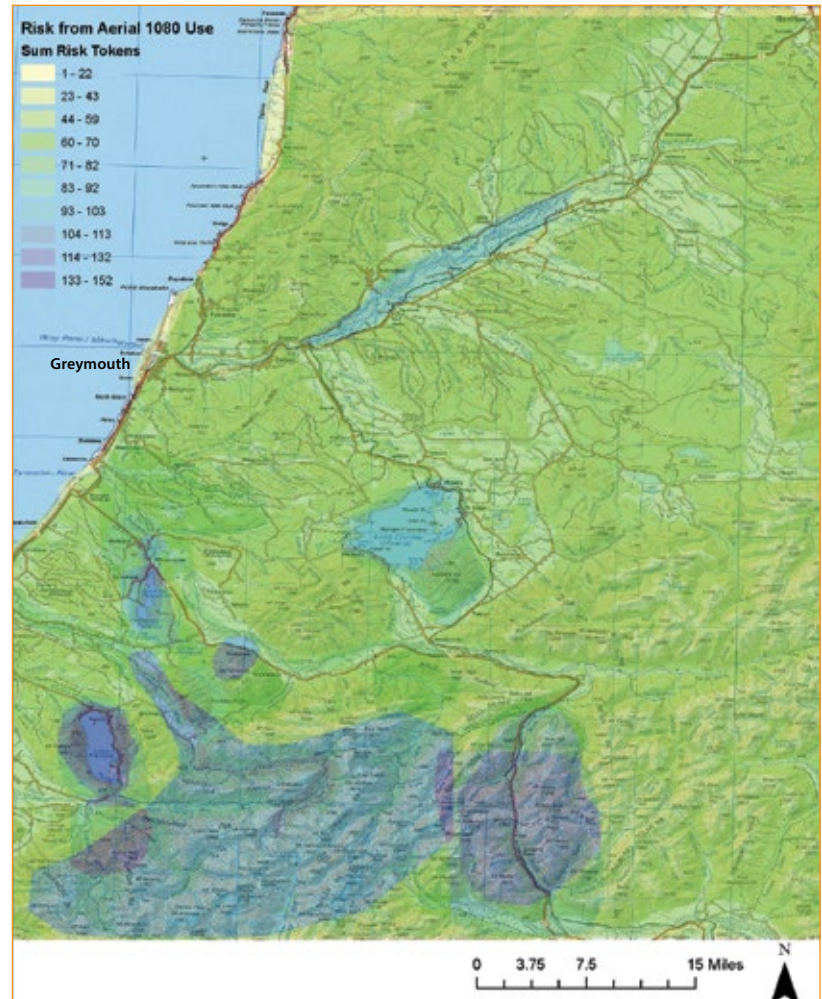


Fig. 2 Citizens' perceived risks from aerial use of 1080. Greatest risks were thought to occur to water catchments such as Lake Kaniere and the Kumara reservoir.



How can science guide best-practice pest management?

Biotic invasions of plant and animal pests and pathogens pose serious threats to indigenous biodiversity, ecosystem function and services, and agricultural productivity. Pest management is complex and ideally integrates knowledge of the species' biology, our ability to detect and control populations, and their impacts on the ecosystem. Despite the voluminous amount of ecological research focused on pest species, this research rarely helps managers identify optimal bio-economic pest-management strategies. A consequence of the disconnect between science and management is that financially-constrained managers are left with a 'trial-and-error' approach that may be based on extensive ecological experience but lacks a formal mechanism for assessing management impacts and guiding improvements.

Dean Anderson and colleagues from the Invasive Animals Cooperative Research Centre (IA CRC) in Australia are currently investigating how science can better guide best-practice pest management. They suggest that the disconnect between science and pest management is influenced by the fact that questions addressed by the two groups are fundamentally different. Answers to management questions result in actions on the ground, such as when, where and how to apply resources to achieve objectives (e.g. eradication, control, containment). On the other hand,

ecologists address questions related to biological or detection processes (e.g. dispersal, population dynamics, detection probabilities). While research findings may contribute to management, decisions that are based on a single process (e.g. home-range size, herbivory rates, dispersal) may be ineffective or result in unexpected outcomes because system dynamics result from a complex web of interacting processes.

To help managers identify optimal bio-economic pest-management strategies, the IA CRC team has developed a research framework for use by collaborating managers and applied ecologists (*Fig.*). Importantly, the process requires ongoing engagement with managers. **The framework has five integrated elements:** (1) management questions, which will result in actions on the ground; (2) identification and investigation of biological and detection processes; (3) pathway analyses and impact assessment; (4) inferential and predictive modelling of potential management scenarios; and (5) bio-economic decision theory to incorporate economic, social and political constraints (*Fig.*). Research questions are built into the framework to address specific stakeholder needs. Because the framework is inherently system-specific and explores relevant management scenarios, the process increases the likelihood that evidence-based management will be applied. Ongoing collaboration between managers

and researchers allows for adaptive management in which ecological models are improved by testing predictions against results from operational trials. In addition, theoretical insights are achieved through the examination of complex interactions of biological and detection processes; an outcome appealing to both managers and ecologists.

The five elements described above are not novel. However, their integration to explicitly address management questions is rarely implemented. The framework is flexible in that existing or novel approaches can be used to address any of the five elements. Also, the skills required to integrate all five elements usually requires a team with diverse skill sets. As a result of their work, Dean and the team anticipate a reduction in the gap between researchers and pest managers over time by: (1) applied ecologists beginning new research projects with stakeholder engagement and questions; and (2) managers seeking capability/collaboration to undertake the comprehensive adaptive management approach. Two recent examples of the team's approach are described below.

Example 1: The adaptive management of stoats on Resolution Island

Stoats persist on the near-shore Resolution Island despite 6 years of trapping for biodiversity benefits (see *Kararehe Kino*

Issue 23). The critical management question is where and when to deploy traps to optimise the probability of eradication? Dean and Andrea Byrom collaborated with the Department of Conservation (DOC) to identify major impediments to reaching management objectives: immigration from the mainland, trap shyness, and a residual population of breeding female stoats. The predicted probability of sustained eradication in the next 5 years with the current trapping programme was only 17%. Managers therefore need to intensify efforts to reduce immigration, increase capture rates of stoats on the island, and capture females disproportionately. Using this work as a guide, DOC has now updated its Operational Plan, taking into account the need for increased expenditure to address the impediments to eradication. Viewed as a broad-scale management experiment, the operational changes will be closely monitored and results will be used to

update and improve the ecological-model predictions.

Example 2: Predicting the effectiveness of new strains of rabbit haemorrhagic disease (RHD-Boost)

A new strain of RHD virus is currently being investigated by IA CRC and is scheduled for field release in 2015, but its effectiveness at suppressing rabbit populations is unknown. Dave Ramsey collaborated with Tarnya Cox to model population dynamics of rabbits that are under the influence of multiple RHD strains, to determine the potential ‘on-ground’ outcomes of the release of RHD-Boost, and identify a suitable strategy to detect, with a high degree of statistical power, the level of population suppression achieved. Results suggest that the success of the released strain will depend on the strength of cross-immunity afforded to rabbits surviving wild-type viral strains. If cross-immunity could be overcome, RHD-

Boost should suppress rabbit populations by an additional 10–20% above that achieved by virulent wild-type strains. On the basis of these predictions, managers have now designed a field-monitoring programme to run over 3 years (one year pre-release and two years post-release) that is capable of detecting a 20% population reduction.

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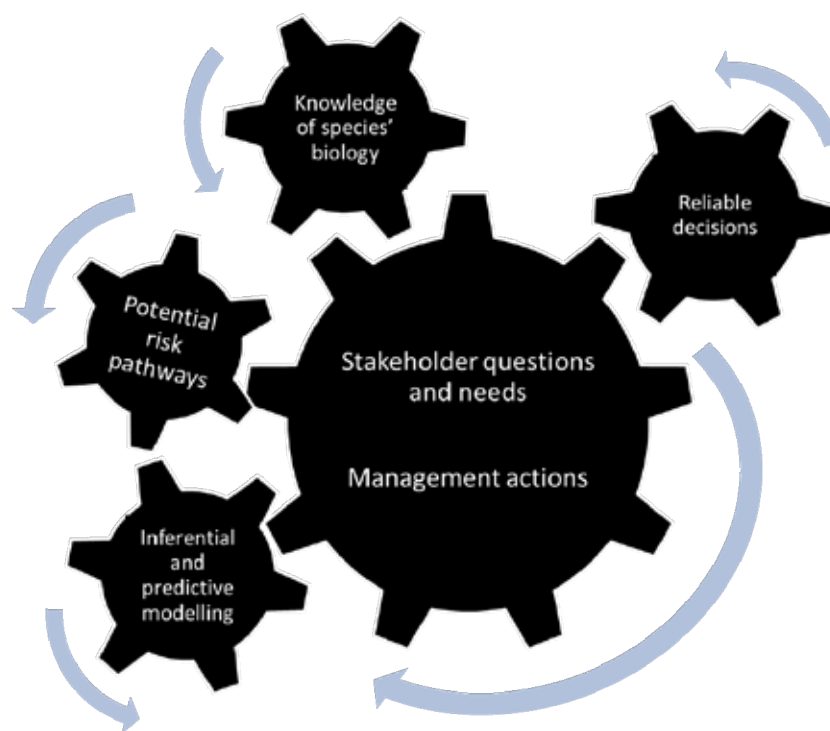


Fig. Comprehensive framework for best-practice pest management. The process places manager needs at the centre: it begins with manager questions and ends with optimal management actions.



Some recent vertebrate-pest-related *publications*

- Buxton RT, Jones C, Moller H, Towns DR 2014.** Drivers of seabird population recovery on New Zealand islands after predator eradication. *Conservation Biology* 28: 333–344.
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- MacLeod CJ, Moller H 2013.** Environmental monitoring for sustainable land management in New Zealand's production landscapes. NZ Sustainability Dashboard Research Report 13/10. ARGOS. 97 p. http://www.nzdashboard.org.nz/uploads/2/3/7/3/23730248/13_10_environmental_monitoring_framework.pdf
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