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Landcare Research

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Victoria Mason

# Biosecurity and pest management

Kia ora koutou katoa,

This issue of *Discovery* has a focus on biosecurity, one of Landcare Research's major research areas. Biosecurity is the protection of New Zealand's economy and people's health from the risk posed by pests and diseases. It includes preventing new pests and diseases from entering, and controlling or eradicating those pests and diseases already present.

Recent invasions, such as the painted apple moth and varroa bee mite highlight the pressure our borders are under. The Government has put additional resources into increasing both border security and internal surveillance systems – the most visible faces of which are Max, the Biosecurity Beagle; the MAF exotic species hotline (0800 809 966); and the current television series, Border Patrol.

A Biosecurity Strategy is in preparation, co-ordinated by the Biosecurity Council, with the first draft due out for public comment in July/August, leading to implementation in 2003.

One of the big issues for the Strategy is the balance between border security and the management of pests and weeds already here. Risk assessment will be a critical process in managing both these problems. For border security, being better able to identify those species that pose the greatest risk, because of their potential for transport to New Zealand, establishment, spread, and impact, would be an enormous benefit.

It is important, however, not to underestimate the threats posed by species already in New Zealand – both those we know about and those we don't. Recent discoveries of new ant and wasp arrivals highlight the difficulties of adequate internal surveillance and the subsequent need for ecological impact assessments. And for plants, New Zealand may be sitting on an ecological time bomb. Of the 20,000 alien plant species currently in the country, about 10-15 become naturalised each year; more than 200 have become weeds; and almost certainly serious future weeds exist in this huge pool of exotic species. Identifying these is another key role for risk assessment systems.

For the control of existing pests, while revolutionary new approaches are being researched, for now incremental improvements in tools and strategies are likely to make the greatest contribution. Identifying goals for pest reductions, better targeting of pests using new detection and mapping tools and more cost-effective, humane and target-specific control systems are all high priority research areas.

Landcare Research is addressing all of these key biosecurity and pest management issues. Our progress towards resolving these challenges is described in some of the accompanying articles.

Phil Cowan

Dr Phil Cowan
Science Manager, Biosecurity and Pest Management
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Photo credits: left to right, Harley Betts 1, 2, 6, 8, Dave Morgan 3, Landcare Research Slide Collection 4, 5, Peter Buchanan 7.

# ECOSAT – An eagle eye on possums

The war against possums is the first cause to benefit from groundbreaking new technology that trims thousands of dollars off the process of interpreting satellite pictures.

Satellite images are useful for environmental monitoring. However, New Zealand's hilly terrain creates problems in interpreting satellite imagery. In an unaltered satellite image, hills and mountains create varying lighting conditions ranging from brightly illuminated to fully shadowed, making it difficult for computers to interpret features by colour and brightness. Added complications arise from reflection of light from vegetation canopies. Because of these complications, it can take many months of work to extract information such as possum habitats.

In a world-first achievement, Landcare Research scientists worked out a string of complex calculations to 'flatten' the effects of topography in satellite images. This new technique, ECOSAT, allows images to be processed automatically by computer to map different environmental features, e.g. regional maps at 1:50,000 scale of woody vegetation - forests, plantations, scrublands, shelter belts, copses and thickets. The Wellington Regional Council has been the first to benefit.

Landcare Research scientist John Dymond says ECOSAT is helping the council to manage its possum control operations far more effectively. "Possums can make dens in any kind of woody vegetation. It is important to know the distribution of these areas, as scattered scrub and shelterbelts on farmland can support a high number of possums.

"ECOSAT gives an immediate map of all the possum habitats in a region. Previously it took council staff several months to extract data for just part of their region from aerial photographs. Obviously the time saved is a major financial saving as well. Now this money can be channelled into actually killing possums, rather than just finding out where they might be. As an extra benefit, ECOSAT can also indicate where possum trap lines should be laid.

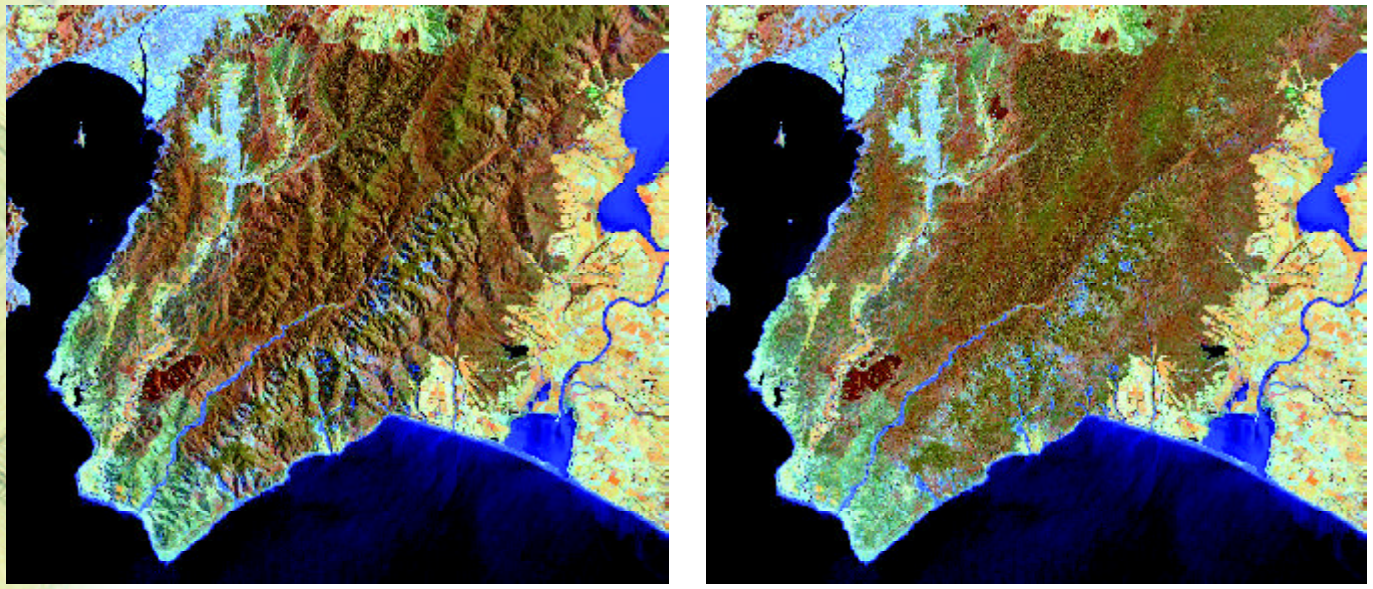
"ECOSAT data is derived primarily from the American Landsat 7 satellite, images from which cover an area 180 kilometres square with spatial accuracy to 15 metres. ECOSAT can identify woody patches down to five metres in size, and therefore may be routinely used to update changes in scrub or exotic forest."

Big things are already planned for ECOSAT's future. "We have had talks with several other regional authorities, including Environment Canterbury, Environment Bay of Plenty, and horizons.mw, who are also interested in using ECOSAT to help them battle possums," Mr Dymond says.

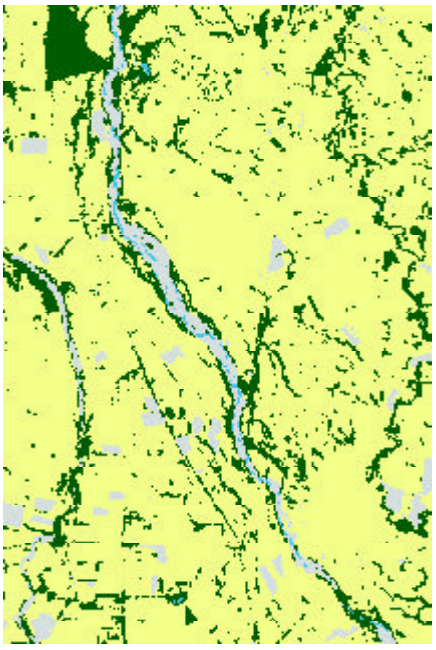
"We also plan to extend the use of ECOSAT to monitor wetlands, the condition of high country in the South Island, the vegetation status of riparian zones, and the habitats of birds and other animals besides possums. ECOSAT will also help identify ecosystems worthy of conservation."

The world-first ECOSAT technology is attracting the attention of agencies in the United States, France, Russia, and Australia.

Funding: FRST (Foundation for Research, Science and Technology)



***An unaltered satellite image of the Wellington area, and an image 'flattened' to remove the effects of topography.***



***Further processing of 'flattened' image results in an ECOSAT map of possum habitat for a whole region (far left), comparable in detail with aerial photo (left).***

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## Monitoring tool helps reduce Tb levels

Landcare Research has spearheaded the development of a practical tool for monitoring possum numbers that has helped turn the tide on the number of livestock infected with bovine Tb. The tool has been so successful, it is now being refined to cope with the conditions created by its success.

As well as wreaking havoc on our native ecosystems, possums spread Tb to cattle and deer, especially where pastures adjoin bush. The disease is one of New Zealand's most serious animal health problems, and to protect our export markets, we need to get Tb levels below those of our competitors and trading partners.

In association with the National Possum Control Agencies (NPCA), Landcare Research developed the National Trap Catch Protocol to guide control contractors and agency staff who carry out possum surveys. The protocol is a standardised trapping system to measure whether possum control targets such as those set by the Animal Health Board (AHB) have been met. If targets are met, contractors get paid, and Tb rates decline. If targets are NOT met, the disease persists, and Tb reactor numbers in herds remain unacceptably high.

The Animal Health Board's technical director, Paul Livingstone, says the National Trap Catch Protocol has made "a significant contribution to the gradual reduction of Tb reactor numbers." Landcare Research scientist Bruce Warburton says this is because the protocol ensures that monitoring surveys are carried out in a consistent way, and has led to more accurate assessments of the number of possums that survive control operations.

"Before the protocol was developed, everybody measured possum abundance using different techniques and sampling methods," says Mr Warburton. "People tended to set traps where the terrain was most accessible, and according to where they thought possums would or would not be. There was no way to be really sure that control targets were being met.

"By contrast, the protocol requires that all possum habitat in a monitoring area must have an equal chance of being sampled, and the starting point for trap lines must be chosen at random. This is very important to avoid any bias in the trap estimates obtained. The

Keven Drew

***The pesky possum – an agent for the spread of bovine Tb.***

protocol also specifies how many traps are to be used on a line, acceptable trap types, lures, setting methods, and weather conditions to work in with. Usually, leg-hold traps are set for three fine nights, and contractors record details of possums trapped on a standardised form each day.

"The NPCA runs trap-catch monitoring courses to train people to be accredited monitors. This is to ensure that standards are maintained and that monitoring is done in accordance with the protocol."

The protocol's success has created new challenges. Initially, the AHB set control targets of 5% trap-catch, or five possums caught in 100 trap-nights. But as possum numbers have been reduced, targets have also been reduced, sometimes to as low as 1%. These very low targets challenge the trap-catch method to provide statistically robust estimates of possum abundance.

"The protocol is a relatively blunt instrument," Mr Warburton says. "It was designed to balance the need for some degree of statistical robustness with a practical method that could be used in the field.

"We are now working with the AHB to refine the protocol so it works better at very low possum numbers. We are also fine-tuning it to take better account of variations in seasons and habitats, and to deal with several vexing issues. These include whether to count a possum that has escaped a trap as a capture, how to monitor possums in areas where traps have to be set above ground level because of the presence of kiwi, and how to better detect residual patches of possums."

Funding: Animal Health Board

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## Kūkupa and kohekohe bounce back at Motatau

A unique project to restore a native taonga has resulted in a surge in kūkupa numbers following a crackdown on pests, and the sharing of valuable knowledge between iwi and scientists.

Over the years, kūkupa (also known as kererū or native pigeon) in the Motatau forest near Whangarei have been in decline, their eggs falling prey to possums and ship rats. In 1996, an eclectic group of Landcare Research scientists, Department of Conservation staff, and Ngāti Hine tangata whenua embarked on a project to find out the extent to which the birds and vegetation in the forest recover after pest control. They also looked at how iwi could continue to protect the birds and forest from pests long after the project's end.

Landcare Research scientist John Innes, one of the project leaders, says that initially, monitoring kūkupa's nesting success was depressing.

"All 13 of the kūkupa nests located between September '96 and October '97 failed at the egg stage, mainly due to predation," says Mr Innes. "In fact, no nest lasted longer than 10 days."

However, kūkupa fared much better after DOC began pest control measures in the forest in October 1997. "In the 1998-99 season, when rats and possums were very scarce, all seven located nests fledged young." But the kūkupa breeding success declined again as few nests fledged in 2000-01, when possums were still scarce but rats had recovered and were abundant.


***Kūkupa, the native pigeon. Visitors to Motatau are now seeing flocks of up to 30 kūkupa flying overhead, where previously it was rare to see five.***

"Taken together, these data suggest that both possums and rats must be at very low levels for most kūkupa nests to succeed," Mr Innes says. "For possums, this means a trap catch of less than 5% — in other words, for possums to be caught in fewer than five of every 100 traps set.

Mr Innes says this confirms that pest control expenditure for kūkupa is wasted unless the pests reach very low levels after control. "Pest control must be highly effective, or it should not be done at all."

Meanwhile, Mr Innes' colleague Graham Nugent monitored recovery of forest vegetation following pest

control. "The broadleaved tree kohekohe is one of the possums' favourite foods, and it made a spectacular recovery with fewer possums around. In just two years, its overall leaf cover improved by about 40%.

"Only 2% of the kohekohe died at Motatau compared with 11% in a neighbouring forest with no possum control," Mr Nugent says. "Māhoe (a small tree) and mamaku (a tree fern) also benefited substantially."

In March this year, a hui was held to wind up the Motatau project. However, a new and larger restoration project, Taiao Mauri Ora Taitokerau (Healthy Northland), conceived by Kevin Prime of Ngāti Hine, has sprung up in its wake.

"We have seen a real turnaround at Motatau," Mr Prime says. "We had pest control measures there before Landcare Research's involvement, but their scientific experience was the key to getting good results.

"Now we want to extend the benefit of what we have learned to other taonga, in the true spirit of kaitiakitanga or guardianship. We have purchased surrounding land and aim to restore kiwi and tuna (eels) as well as kūkupa."

Funding: FRST (Foundation for Research, Science and Technology), Department of Conservation

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## Tracing greenhouse gases in dairy pastures

It may not be evident from the clean green image, but New Zealand has a unique greenhouse gas problem. Our many millions of sheep and cattle produce considerable quantities of methane ($CH_4$) and nitrous oxide ($N_2O$).

This places New Zealand among the top greenhouse-gas-producing nations per capita. Landcare Research scientists have taken major steps towards finding out how much nitrous oxide is emitted in this country, and what can be done to reduce the amount.

Although much greenhouse gas publicity focuses on carbon dioxide, methane is 21 times more effective at trapping the heat of the sun, and nitrous oxide an astonishing 310 times more effective. Nitrous oxide is thought to make up about a sixth of New Zealand's greenhouse gas output. It is generated mainly from surplus nitrogen in soils, which originates from dung and urine of sheep and cattle. The problem is unique to New Zealand, where farm animals have the luxury of dining mainly on pastures, not supplementary feed. No other country has such a dominance of methane and nitrous oxide in their greenhouse gas inventory.

Reducing nitrous oxide is clearly a pressing need. The Intergovernmental Panel on Climate Change (IPCC) has designed a system to calculate nitrous oxide emissions throughout the world. But as Landcare Research scientist Dr Surinder Saggar says, it is inadequate for New Zealand conditions, as it does not account for differences in climate and soil type — the two main variables controlling emissions here. Landcare Research scientists have designed a new improved model — the NZ-DNDC (denitrification/decomposition).

"The NZ-DNDC is modified to simulate emissions on both regional and national scales from New Zealand's pastoral systems under a wide range of conditions," Dr Saggar says. "It assesses climate conditions, soils, grazing, and excretal nitrogen inputs."

Landcare Research staff took intensive measurements of emissions from grazed and ungrazed dairy pastures at Massey University, near Palmerston North. They examined the variation in results from two different soil types, and assessed the influence on emissions of environmental variables such as rain, soil moisture, temperature and available nitrogen. The results formed the basis of NZ-DNDC's parameters.

### Major findings

Preliminary estimates using the NZ-DNDC model indicate that New Zealand's direct nitrous oxide emissions are about 18 thousand tonnes a year. Within each region the estimates vary from year to year depending on rainfall distribution and the amount of time stock spend in paddocks.

The NZ-DNDC model also includes information on the importance of soil quality on nitrous oxide emissions. "Poorly

Carolyn Hedley, Massey University

***Surinder Saggar using an especially designed chamber to collect nitrous oxide samples from a dairy pasture.***

drained soils make the problem much worse," says Dr Saggar. "Our early estimate is that the 9% of our dairy pastures that are on poorly drained soils are responsible for about 20% of the nitrous oxide emissions.

"Armed with this information, government agencies may decide to invest money in soil drainage, or introduce restricted grazing during winter when soils are wet and the emissions are the highest."

Dr Saggar says the NZ-DNDC model could be further developed to simultaneously provide estimates of nitrous oxide, methane and carbon dioxide emissions.

"All in all, the model is an extremely useful tool for identifying exactly where, and to what degree, these emissions are a problem. Once we know these factors, we will know better how to help reduce emissions and to see how successful our efforts are."

"This will help New Zealand meet its IPCC requirements beyond 2012."

Funding: FRST (Foundation for Research, Science and Technology)

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## Patience and the art of penguin watching

It is a project that has come of age. For 21 years, Landcare Research scientist Dr Peter Wilson has traded Nelson's sun, sand and surf for summers in the Antarctic snow, discovering what regulates Adélie penguin numbers. It has taken that long to determine the difference between anomalies and clear trends. Now this patient research is seen as internationally significant, as the world considers the twin evils of global warming and overfishing.

Of all the predators in Antarctica, Adélies may have the most to teach us about environmental health. Changes in Adélie populations can be used to detect climate change and show the impact of fishing. As well as fish, Adélies eat krill, the key component of the food web. The information gathered is vital to the Convention of Antarctic Marine Living Resources (CCAMLR), which draws up international fishing agreements for the Antarctic waters of the Southern Ocean.

Adélies breed during summer when Antarctica is most accessible to researchers, and, unlike most Antarctic marine animals, are easily counted. Dr Wilson, his American collaborators, and teams of Landcare Research scientists have been studying Adélie colonies on Ross Island. They examine the penguin's numbers, migratory patterns, diet, and foraging success.

Adélies have been in the news recently, thanks to an iceberg the size of Sicily that broke off the Ross Ice Shelf over summer, possibly as a result of global warming. This forced many penguins to walk for 40 hours to their breeding grounds, and blocked their access to fishing waters. Almost all the summer's chicks died. More recently, another massive iceberg broke off immediately adjacent to the largest colony at Cape Crozier. The Ross Island Adélies may again face a disastrous year for breeding.

Bruce Thomas

***Dr Peter Wilson, photographing Adélie Penguins***

A catastrophe? "No, or at least not yet," says Dr Wilson, who would not have known this without the benefit of a long-term overview. "If the situation persists, we would expect to see a serious decline in the number of breeding pairs. But Adélie penguin numbers in the Ross Sea region have risen, on the whole."

Dr Wilson explains this is due in part to air warming over the past 40 years. A sharp rise in the numbers of breeding pairs from 1981 to 1987 can be linked to an overall reduction in floating ice during summer. In winter, Adélies follow expanding sea ice north, and if ice masses become too large, penguins can be

separated from good food sources. In years of extensive winter sea ice, Dr Wilson and his team discovered that fewer juveniles survive to reach breeding age. This has caused the population to decline, but not to pre-1980's levels.

Dr Wilson says it is clear that global warming does have an influence on populations. Penguins in colder, more southerly latitudes can benefit because less sea ice may mean they can access their colonies and food more easily. But colonies in slightly warmer climes are more likely to suffer, as too little sea ice provides fewer platforms for feeding, and also makes populations decline.

The scientists have also studied penguin diet and foraging. The information they have gathered from the relatively untouched Ross Sea area provides a crucial comparison with colonies near fishing operations.

"Our work is of great benefit to the world's understanding of the marine environment and future conservation needs. It is also a major contribution to New Zealand's responsibilities in the Ross Sea Dependency.

"However, we could not have afforded such a long-term, intensive study without indirect funding assistance from the United States, through collaboration with their expert personnel, and shared use of expensive equipment."

Kerry Barton

***Adélie penguins***

Dr Wilson says several important areas of research present themselves for the next couple of years. "We want to study the fortunes of colonies in the northern Ross Sea, where the climate is warmer, and the commercially targeted krill is an important component of penguins' diet during the breeding season."

After 21 years on the ice, it is clear that Dr Wilson's admiration for Adélies has not dimmed. "They are tough, stoic and resolute. I can only respect their will to overcome huge obstacles, even gigantic icebergs."

Funding: Foundation for Research, Science and Technology (FRST), National Science Foundation (United States)

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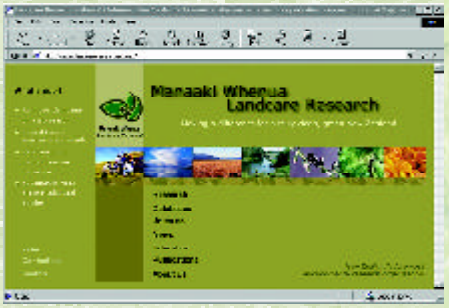
## New Website

Landcare Research's new public website is now online at www.LandcareResearch.co.nz

The website has been extensively redesigned and updated with a far greater range of information. Its new features include:

- A reorganised research section to present the work and capabilities of Landcare Research
- Access to new scientific databases
- Improved access to publications
- New educational resources for both students and teachers
- More illustrations and photographs
- More dynamic Jobs and News sections
- A superior search function that picks up Word and PDF files

The website is designed to be relevant to anyone with an interest in New Zealand's environment.

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# Intelligent new weapon in war against pests

New Zealand as an island nation constantly battles the threat of introduced weeds and pests. With ever-increasing trade volumes and tourism, we must always be on guard against invaders. But with our limited resources, what should we be most vigilant against? Which plants, insects and mammals have the greatest potential to run rampant here, to the detriment of native ecosystems?

Landcare Research is leading a project to develop the most comprehensive computerised risk profile system in the world. BIOSECURE is a web-based system to help biosecurity authorities decide where best to focus their resources, to stop pests arriving, establishing, and spreading. It has direct applications in the development of import health standards, and will guide border control policies and operations. A prototype is now ready to be trialled by staff from the Department of Conservation and Ministry of Agriculture and Forestry. Users log on, fill out fields specific to their real or hypothetical invasive species problem, and BIOSECURE posts a results report.

Landcare Research scientist Gary Barker leads the BIOSECURE project. Mr Barker says, in compiling a series of steps to estimate risks of invasion, his team soon realised that conventional approaches were too simplistic.

"Traditionally, agencies have used expert opinion and computer programmes to compare a potential invader's home climate with New Zealand's climate. They may also make assessments of biological traits that could allow an organism to be invasive in New Zealand. But in designing BIOSECURE, we quickly realised that these factors differ for each invader and each ecosystem. We knew we needed a more holistic approach.

***The fire ant from Brazil - a potential exotic invader. A nest of these aggressive stinging ants was found near Auckland International Airport in March last year, but the nest was treated and all known ants were killed. BIOSECURE will help biosecurity authorities to keep pests like these ants out of New Zealand.***

"BIOSECURE helps to estimate risks of alien species gaining a foothold in any part of New Zealand. It gives biosecurity agencies the ability to run risk analyses with a wide range of environmental indicators, including climate, potential food availability, soil fertility, and whether enemies and competitors are present," Mr Barker says.

"Alien species often thrive in new climatic conditions if they do not have their usual enemies and competitors to keep their numbers down. BIOSECURE takes account of this."

Mr Barker says BIOSECURE also factors in the degree of human disturbance in New Zealand ecosystems, such as deforestation and introduction of exotic plants. "There is ample evidence that these disturbances make an ecosystem more vulnerable to invasion. And of course, BIOSECURE looks at an ecosystem's proximity to ports of entry, which countries these ports receive goods from, and how those goods spread out within New Zealand.

"BIOSECURE also examines the potential for ecosystem damage in different parts of New Zealand. Damage is assessed in terms of indigenous biodiversity, tourism, and Māori cultural values."

Landcare Research will continue to work with biosecurity agencies to refine and use BIOSECURE.

Funding: Foundation for Research, Science and Technology (FRST), Landcare Research investment.

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