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Special Contribution

Forest Biosecurity - a forest manager's viewpoint

The relationship between science and management: Opportunities and constraints in the New Zealand biosecurity context†

Biosecurity is about protecting things. Before we can protect things, we need to understand what it is we are trying to protect. In New Zealand's case we are trying to protect our unique indigenous fauna and flora, our economic base, and our landscape and lifestyle assets.

New Zealand is a paradox. It produces natural products (wood, butter, kiwifruit, meat, wool or milk) obtained from introduced plants (e.g. pine trees and kiwifruit) and animals (cows and sheep) then trades them with the rest of the world to make a living. Yet New Zealand's isolation at the bottom of the South Pacific means that many pests of these introduced plants and animals do not naturally occur here. They may arrive at some point in the future, however, as a result of importing goods. Consequently, New Zealand is very concerned with the biological risks the rest of the world poses to its economy and has a very stringent and protectionist approach to biosecurity. One option would be to simply close New Zealand's borders to imported goods. In reality, this is not a viable solution so the country has accepted that it will be exposed to some biosecurity risks.

Risk profiles change and evolve as we trade in a diverse range of products with a number of different countries. For example, 20 years ago a new problem arose when somebody realised that cheap second-hand cars could be imported from Japan. This new trade suddenly exposed New Zealand to a whole new set of risks from Asian insects hitching a ride to the Antipodes. Another recent example is the importation of palm kernel for feeding dairy cows, a trade that did not exist a handful of years ago. Now we import a million tonnes a year, with the potential risk that brings.

Integrating science and management in biosecurity

Biosecurity efforts to control pests will be unsuccessful without relevant and sound information obtained from scientific research. To an operational manager (such as myself), science and research are different names for the same thing, perhaps separated by time. Researchers may not agree, but the operational perspective is "I have a problem and I need some research or science to give me an answer".

So how does science support the management of biosecurity threats in New Zealand?

Because operational managers need to know what we are trying to protect, we need to understand what is already here. We also need to understand what else might arrive in the future, how it might get here and what impact it might have when it does. Also, we must never lose sight of the fact that these pathways are constantly evolving.

In reality, we are not capable of identifying every potential threat. There will always be something that we never imagined would be an issue that will become a huge problem when it arrives in New Zealand. Understanding the pathways and the mechanisms by which those threats arrive here is, therefore, an extremely important part of the process.

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We need to develop answers as to how we might eliminate or minimise both threats and pathways but we also need to recognise that some things will beat us. We are not capable of stopping every single potential pest arriving in the country so we need response options to limit the inevitable incursions. We also need to have robust processes for analysing these options in the face of a high level of uncertainty.

Needs and wants

For truly effective and sustainable biosecurity management, it is vital that operational managers and scientists understand each other's needs and wants. Issues and opportunities can range from the pragmatic (i.e. resourcing) to the philosophical.

It is critically important to science that management supports science capability with funding and resources over the long-term, particularly during periods when biosecurity activity is low. High profile pest incursions have seen large budgets applied to research in the last decade but the funding has been stopped once the particular threat has been eradicated. Unfortunately, that process is not sustainable. Training scientists is a long and expensive business and they cannot always be replaced quickly when an urgent need arises. Research capabilities with sufficient depth and breadth to handle major new incursions must be maintained long term. It is critically important in the biosecurity area that there are good stable science positions for experienced staff in order for them to be able to respond to threats when they arise – in effect a standing army.

Different mindsets... different timeframes

Faced with a biosecurity problem, scientists and managers understand that their thought processes and drivers are often very different. This is an important issue.

What do biosecurity managers need from scientists? A biosecurity manager, such as myself, just wants an answer to the problem so I can get rid of this pest. I'm certainly not going to be given the resources and funding to pursue pure science in these circumstances. So scientists need to: respond to biosecurity management needs, not *vice versa*; accept the paradigm that they are dealing with an immediate operational issue; and accept that circumstances can, and will, change.

For example, if we do eradicate a pest, we, as managers, may no longer have any interest in the associated research. The research may be interesting from a science perspective but that doesn't necessarily make it valuable from a management perspective. A scientist is trained to ask 'why'. Come up with a new piece of information and a scientist thinks, "I wonder why that's happened?" The biosecurity manager, on the other hand, thinks (and this might sound a little churlish): "I don't care why!" Biosecurity managers have to try and balance a need for longer term science, in case it takes us a long time to eradicate the pest, against the immediate short term resolution of the problem. Don't take it personally when we managers say "we're not interested in a project any more". It's not a reflection of the science, it's a reflection of the fact that we no longer need that output and have shifted our priorities from Pest A to Pest B.

In my experience, one of the biggest challenges biosecurity managers face in terms of the gap between science and management is that the scientist is trained not to commit to an answer until he or she has absolute statistically valid certainty.

However, a biosecurity manager needs answers... and now. We need to respond immediately - we don't have a year or three to think about what we might do. By definition, we need decisions in the face of uncertainty - 75% of the answer now is worth a lot more to me than 100% in some years' time.

The other crucial issue is that biosecurity managers require ideas to be transformed from merely interesting to practically useful, and we certainly need flexibility and responsiveness from scientists. In many biosecurity situations, as more information comes to hand biosecurity managers often need to change the overall direction of the work. So when we go back to the scientists and say we no longer want them to finish the project we commissioned some time ago, again, it's not personal, it's just that this information is not going to be useful to us anymore. Of course, it is also important to develop some long term strategies because there are fascinating new technologies out there that could deliver huge improvements in knowledge, productivity and confidence.

What do scientists need from biosecurity managers? Firstly, a very clear definition of the problem or challenge is needed. For effective results, biosecurity management needs to articulate its needs clearly to the science fraternity - Pest X has arrived in this location, we believe it is doing damage, and what is the best way of responding to this cost-

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effectively? Management also needs to define the parameters for acceptable answers and in particular the boundaries around how far the science goes. Biosecurity management also needs to impose clear time limits on the science.

I also believe New Zealand's current competitive science model is a huge impediment to the relationship between management and science. The Crown owns most of New Zealand's research institutes and universities, but forces them to compete, so they don't communicate with each other and they replicate and duplicate things, instead of saying "here's a problem that New Zealand is facing - how can we best resolve it?" New Zealand is a small country and doesn't have enough scientists to play that game. I believe the competitive science model is flawed, particularly in the biosecurity arena. The government's new chief science advisor is aware of this issue but there does not appear to be the level of urgency that should always be a hallmark of biosecurity. In biosecurity, responsiveness is always of the essence!

Notwithstanding all the challenges there have been some important successes over the last decade where science and biosecurity management have worked successfully together, both in eradication and in technical advances.

Success stories - eradications

When painted apple moth (*Teia anartoides* Walker) (PAM) was found in west Auckland in 1999 it was deemed to be a risk to forestry and horticulture, to indigenous species and urban plants. Also, because of the urticating hairs, it posed a health risk to children. Following a government decision to eradicate the pest, a large-scale aerial spraying programme over 10,000ha of our largest city was mounted. This was combined with a coordinated multi-agency science programme to examine the ecology, look at spray application and to consider innovative new technologies. The latter included sterile insect techniques and mark-release-recapture of males to determine how far they travelled and various other behavioural characteristics. A number of major science institutes were involved, some of our best scientists in this area were involved for a long time. The net result was that this pest was eradicated from a very large area by 2006 even though the cost was NZ$50 million. Few would doubt that this is one of the great success stories of biosecurity, probably anywhere in the world.

An even more successful campaign, however, was the eradication from Auckland of white spotted tussock moth (*Orgyia thyellina* Butler). It was first found in April 1996 and declared eradicated in June 1998 at a cost of about NZ$12 million.

Yet another success has been the eradication of the Hokkaido gypsy moth (*Lymantria umbrosa* (Butler), which was discovered in Hamilton in a routine surveillance trap. Because we rapidly transfered the learning, technology and scientists from PAM, we were able to eradicate the Hokkaido gypsy moth very quickly, following a relatively small-scale programme to ensure that New Zealand was free of this very destructive pest. It's an important lesson - if you move fast and you haven't lost the knowledge then you can implement a successful strategy very quickly.

Another piece of biosecurity work that sits under the radar for most people is red imported fire ant (RIFA) (*Solenopsis invicta* Buren). There have been three RIFA incursions – all unrelated, all successfully eradicated. An important part of this story is MAF Biosecurity NZ's National Invasive Ant Survey (NIAS) which is carried out every year around all sites at risk of incursions. Every year NIAS picks up significant numbers of new species which are usually rapidly eradicated because they're dealt with immediately.

Success stories – benefits of new technology

There has been an eradication programme in place for over 10 years for the Australian southern saltmarsh mosquito (*Aedes camptorhyncus* (Thomson)). A sound science programme is now supporting decisions about how the eradication programme should be run and we're getting the answers that we need to improve our effectiveness.

Another positive improvement comes from high risk site surveillance (HRSS). High risk sites (i.e. sites where there is a significant risk of new incursions occurring) are monitored and assessed every year for any new incursion, be it fungi, insects or whatever. Areas with large cargo movements and transitional facilities were initially targeted. The programme was extended in 2008/2009 to include 'first night camp sites', amenities and carparks. New technology, including geographical information systems, that capture, store, analyse, manage, and present data that is linked to location, has improved our capacity to capture information and reduce the risk of errors. It also improves our ability to analyse data, identify trends and share information.

A key to any success is the capability to identify the exact species of interest as this will determine the nature of the biosecurity response. Correct species identification raises some interesting issues both from a management and a science perspective. The ability of science to diagnose or identify organisms now exceeds the response capability

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and capacity of biosecurity managers and even that of the statutory processes.

Modern molecular techniques make it possible to identify many organisms with greater precision than just using traditional methods. DNA testing can determine the presence of different strains of an already introduced pest or disease organism which may still pose an incursion risk. This new technology adds a whole new dimension to biosecurity. DNA testing can also reveal exactly which species are actually present. One example involves cypress canker fungi. Historically, it was thought that one particular species (*Seiridum unicorne* (Cooke & Ellis) B. Sutton) was present in New Zealand, but DNA-testing has shown that it is, in fact, a different one, *S. cupressi* (Guba) Boesew. Despite its usefulness, DNA technology can also inadvertently cause problems for the uninitiated. This happens when DNA information leads to the name of an organism being changed. This can cause confusion as it appears that a new species has been introduced when, in fact, it hasn't. One relevant example is with *Phytophthora,* a genus of pathogens that is causing real concern around the world. A species of *Phytophthora* present in New Zealand was identified in 1972 as *P. heveae*, which was first discovered in Malaysia. DNA analysis has shown that the New Zealand species is similar to, but distinct from, the Malaysian species so requires a new name. The temporary new name is "*Phytophthora* taxon Agathis". The new name suggests that the organism is a new introduction but it isn't.

Another technological success story has been major advances in aerial application technology. New Zealand has some of the world's leading people involved in this field. Most countries put their effort into control technology, but New Zealand is geared towards eradication. We have therefore had to develop technology that allows us, in the case of aerial application, to put bait or spray or whatever is being used in front of every individual pest. If dealing with mosquitoes, for example, this may mean putting the control agent in every cow hoof print in a swamp.

Yet another diagnostic technique compares the ratios of certain stable isotopes in order to distinguish related organisms. One New Zealand company did this to show that painted apple moth was a new arrival distinct from other moths already in New Zealand. So the science is getting way ahead of the ability of managers and the statutory framework to keep abreast of it. Biosecurity management then must accept the challenge to keep pace with science and develop systems to adapt to new advances.

Eradication means getting a 100% strike rate, not 95%, so these are huge challenges. New Zealand now has systems that managers and scientists can have a very high level of confidence in. We have developed a skill set that is probably unique in the world in terms of delivering, assessing, measuring and calibrating this equipment. This is something we should be very proud of, and it's the result of cooperative work between science and management.
All these successes are great but, of course, we can still do better.

Working together

What could improve the relationship between biosecurity management and science? At the moment we have a stop-start relationship - we only want each other at certain times, we pay for what we get and then we go our separate ways. This is a big part of the problem – biosecurity management tends to treat research as something that can be turned on and off. Instead, biosecurity managers and scientists need to build on-going relationships and biosecurity managers need to fund core-capability for the long term, so it will always be available when needed. Fundamentally, we've got to love each other more!

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