



Investigating Biological Control

and the HSNO Act

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ENVIRONMENTAL RISK MANAGEMENT AUTHORITY



NGĀ KAIWHAKATŪPATO WHAKARARU TAIAO

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Summary

Biological control (biocontrol) is the use of one living organism to control another. Usually biocontrol does not eradicate the pest, but reduces the spread or vigour of the pest and is used in conjunction with other pest management tools.

Many plants and animals introduced to New Zealand—accidentally or deliberately—have become pests. Most pest species are not closely related to New Zealand's native plants and animals. As such, there is an opportunity to introduce biological control (biocontrol) agents to target pests without endangering native and valued species.

Regulation of biological control agents in New Zealand

Prior to the HSNO Act the process for introducing a biocontrol agent was far less formal with only a simple risk assessment at best. The Hazardous Substance and New Organisms (HSNO) Act 1996 began regulating new organisms, including new biocontrol agents in July 1998. Since then twelve applications to release 17 biocontrol agents have been considered and approved by the Environmental Risk Management Authority (the Authority).

Decision-making process

The HSNO Act provides a mechanism for independent decision-making, imposes a high level of transparency on the process, and allows for public participation.

Information

The HSNO Act specifies information that must be included in an application and things to take into account when making a decision. It places the responsibility of providing the information on the applicant. Researchers find this challenging, as they must provide very extensive and comprehensive information about host-range and potential non-target effects. This has influenced the amount and direction of biocontrol research in New Zealand.

Approach to risk and uncertainty

The HSNO Act is inherently precautionary. It requires an approval before the introduction of all new organisms on the premise that they will have effects on the environment to some degree. It also directs the decision-makers to be cautious where there is scientific and technical uncertainty.

The HSNO Act is perceived as encouraging the decision-makers to be very risk averse. There is a perception that by regulating biocontrol and genetic modification under the same legislation, the HSNO Act has increased the public's concern about new biocontrol agents.

Impacts of regulation on biological control in New Zealand

Some researchers believe having a well-regulated process with specific timeframes and guidelines is the reason why New Zealand is one of the few countries in the world still releasing biocontrol agents. The HSNO Act is also heralded as requiring robust scientific information. However, the HSNO Act is also blamed for the high costs associated with introducing a new biocontrol agent, and limiting the types and number of biocontrol agents being introduced into New Zealand.

Costs

The HSNO Act imposes costs in the form of application fees, information requirements and public consultation. However, the increase in costs is not matched by an increase in funding. The overall high costs also mean biocontrol is not a financially viable pest control option for

small or private industries that are unable to receive public funding and have little research and development funding of their own.

Limited types of biocontrol agents

Neither the HSNO Act nor ERMA policy defines what constitutes a *significant* adverse effect. As a result applicants are not sure what level of risk is acceptable and tend to take a very conservative approach, limiting their investigations to agents they are confident will be approved. Therefore, there is a risk that New Zealand could be missing out on better biocontrol options.

Effectiveness of the HSNO Act regime

Biocontrol agents approved under the HSNO Act regime

To date, there is no evidence of any adverse effects on the environment or health and safety of people resulting from the release of a biocontrol agent under the HSNO Act. This would infer that the Act is effective at achieving its purpose at this point in time. However, establishment of a biocontrol agent can take many years and biocontrol agents released under the Act have only been in the New Zealand environment for a relatively short time. Therefore, it is too soon to make definite conclusions regarding their success as a biocontrol, or their adverse effects on the environment.

Comparison to previous regimes

The Act is very specific about taking account of adverse effects on the environment, while introductions made prior to the HSNO Act were based on whether the biocontrol was likely to successfully control the pest. Therefore, it could be concluded that decisions made under the Act are much safer for the New Zealand environment than previously. However, the amount and type of research around non-target effects was already increasing in the years leading up to the introduction of the HSNO Act. In addition, many decisions made in the 1990s included similar considerations as those made since the HSNO Act came into force.

Many biocontrol researchers believe that the HSNO Act has not resulted in better decisions, just better documented, more transparent, and more considered decisions than previously.

The cost of the HSNO Act regime to New Zealand

While the Act is effectively protecting the environment, it appears to be coming at a cost of potentially limiting the types of biocontrol agents being released. The high financial costs associated with researching unknown non-target effects, combined with an uncertainty around the acceptable level of risk is influencing researchers to select biocontrol agents whose non-target effects are easier to identify and more likely to be approved. The high costs and lack of funding is also preventing smaller industries from making applications.

Some researchers initially believed the HSNO Act was so restrictive it would end all introductions of biocontrol agents. Many researchers now believe the independent and transparent process created by the Act is the main reason why releases of new biocontrol agent are continuing in New Zealand.

Potential for deliberate non-compliance

The high costs of obtaining approval under the HSNO Act could create an increase in illegal releases of new organisms, which in turn could create significant adverse effects on the environment. This is particularly a concern if the regulatory hurdles are perceived as being unachievable and there is a mechanism available to avoid them.

Introduction

ERMA New Zealand has undertaken an investigation into the effectiveness of the HSNO Act in regulating new organisms that are biological control (biocontrol) agents as part of ERMA New Zealand's monitoring programme.

ERMA New Zealand's monitoring programme looks at the effectiveness of the HSNO Act in protecting the environment, and the health and safety of people and communities, by preventing or managing the adverse effects of new organisms and hazardous substances.

With regard to biological control in New Zealand, this study examines:

- the HSNO Act decision-making process;
- how the HSNO Act deals with risk and uncertainty;
- the impact of the HSNO Act on research;
- the costs imposed by the HSNO Act;
- biocontrol agents approved under the HSNO Act;
- the effectiveness of the decisions made under the HSNO Act; and
- the cost to New Zealand of having the HSNO Act.

This report is based on questionnaire responses and discussions with biocontrol researchers in New Zealand, industry groups and other interested parties. Information collection, questionnaires and interviews were undertaken in September to November 2009.

What is biocontrol?

Biological control or biocontrol is the use of one living organism, usually a specialised natural enemy, to control another living organism (the target pest). This can involve antagonists, competitors, parasitoids, pathogens, or predators to reduce the abundance of the pest population so that it causes less damage.

How does biocontrol work?

Generally, biocontrol does not eradicate the pest organism, but works to reduce the spread or vigour of the pests that are present. In the case of weed biocontrol, agents may attack the adult plant – eating leaves, boring stems etc, to reduce the vigour of the plants, or they may eat the seeds or fruits of the plant to reduce the spread of the plant. The action of the biocontrol is important in measuring the 'success' of the agent – if the agent is reducing seeds or fruit, a reduction in the existing weed cover areas is unlikely. However, it is likely that there would be a reduction in the spread of the weed over time. That is, the existing infestation areas would remain the same size, but fewer new infestation sites would appear.

Types of biocontrol

Classical biocontrol

Classical biocontrol, involving the deliberate introduction of exotic natural enemies to the habitat of the exotic pest species, is a common type of biocontrol in New Zealand. This has the benefit that once an agent has established, no further input is required except in some cases to move the agent to other locations.

Augmentation biocontrol

Augmentation biological control involves artificially rearing and releasing the biological control agents at the site where control is required. This is used when natural enemies are scarce, and therefore unable to reach the pest (eg in a glasshouse), or are slow to arrive and establish at sites (eg new plantings).

Augmentation can be expensive as it can be costly to rear organisms for release, so is mainly used when the agent is easy to rear or the crop is very valuable. Augmentation can be inoculative (introduced to grow and reproduce, usually targeted at subsequent pest generations) or inundative (mass release, usually targeted at the current pest generation).

Inoculative biocontrol

An inoculative release involves the introduction of a biocontrol agent that is expected to grow and reproduce. This is often used early in the crop cycle, provided the agent is able to breed sufficiently fast to keep up with the pest population.

Inundative biocontrol

Inundative or mass release biocontrol is used in situations where the agent is unlikely to establish or breed fast enough to keep up with the pest. This may require multiple releases of the biocontrol agent through the season. Examples of inundative biocontrol used in New Zealand include the use of *Encarsia formosa* (parasitoid) to control whitefly and *Phytoseiulus persimilis* (predator mite species) to control two-spotted spider mite in greenhouses.

Another type of inundative biocontrol are biopesticides/bioherbicides. These are pathogens (often bacteria or fungi) mass-produced in vitro and applied to pests in the field. The pathogen kills the pest, but does not establish, and therefore has a short-lived control. An example of a biopesticide is the commercially available spray containing *Bacillus thuringiensis* that is used to control moths and butterfly. Commercial sprays have been available since the 1930s, and are effective as a replacement for pesticides.

Conservation biocontrol

Conservation biological control assumes that the natural enemies of the pest are already present in the environment, and that their numbers can be increased through a variety of techniques.

The New Zealand Context

There is a long history of biocontrol in New Zealand. Many organisms have been introduced to control both exotic and indigenous pests and weeds. The first recorded deliberate introduction of a biocontrol agent was *Coccinella undecimpunctata* (the 11-spotted ladybird) for the control of aphids, in 1874 (Cameron, 1989). The most recent biocontrol agent approved for introduction is the lace bug (*Gargaphia decoris*) to control the weed woolly nightshade (*Solanum mauritianum*), which was approved in 2009.

An isolated evolution

New Zealand is an archipelago located in the South Pacific Ocean with the three main islands extending from 34°S to 47°S, some 1600km from the nearest continent, Australia. New Zealand's isolation and maritime influenced temperate climate has resulted in the evolution of a unique indigenous flora and fauna. It also limited the pests and diseases present in the environment.

New Zealand's isolation ended a thousand years ago when the first humans arrived. Since then an abundance of plants and animals have been introduced, either by accident or deliberately.

A history of introducing exotic species

East Polynesian colonists introduced kiore (rat), kuri (dog) and half a dozen plant species. Ship rats, pigs, goats and some species of vegetables arrived through Cook's voyages. Sealers and whalers had brought with them dogs and cats, more pigs, and more fruit and vegetables. Birds, animals and fish were imported by local acclimatisation societies so that, according to one of them, '*the sportsman and lover of nature might then enjoy the same sports and studies that make the remembrance of their former homes so dear, the country rendered more enjoyable, our tables better supplied...*' (King, 2003).

Sheep and cattle were introduced from the 1830s, and wool was to become the country's major export in the nineteenth century. The largest sheep-runs in the country were established on the South Island golden tussock grasslands, which were often ploughed or burnt over and sowed with English grasses. In the North Island, forests were cleared and grass sown for the establishment of the sheep industry. In the 1860s, introduced species included salmon, rainbow trout, Californian quail, *Pinus radiata* and macrocarpa from the United States; starlings, blackbirds, sparrows, gorse, foxgloves, rabbits and red deer from Britain; black swans, possums, green frogs and eucalypts from Australia (King, 2003).

A catalogue of pests

Many of the animals and plants introduced by humans have become pests in New Zealand. Introduced crops, trees and ornamental plants also carried with them a myriad of pests and diseases, including some natural enemies of those pests and diseases. The changes in land use; forests converted to pasture, native grasses replaced by exotic grasses, exotic forestry and crop cultivation; resulted in favourable conditions for exotic plants, insects and pathogens to thrive. Some native species have also become pests in the changed environment.

A potential solution

Agriculture remains hugely important to New Zealand in terms of both image and export trade. Farming (dairy, sheep (wool and meat), beef cattle, deer, goats and pigs, poultry, bees, crops, fruit and vegetables, viticulture, and aquaculture), forestry and fisheries are important to the New Zealand economy and are vulnerable to exotic pests.

Many of the exotic species that have thrived and become pests in New Zealand are not pests in their native range. This is often because their natural enemies are not present in New Zealand, and they are not targeted by any native species. Consequently, there is potential to introduce natural enemies of those pests into New Zealand that target unwanted introduced species. In addition, because of the unique nature of New Zealand's indigenous flora and fauna, it is possible that exotic biocontrol agents will not affect native species.

Regulation of biocontrol in New Zealand

In the earliest days of biocontrol there were no regulatory limitations on what organisms (plants, animals, or insects) could be introduced into New Zealand.

The introduction of the Plants Act 1970, the Introduction and Quarantine of Plants Regulations 1973, and the Forest Pest and Disease Control Regulations 1967 coincided with a renewed interest and investment in biocontrol resulting from a change in perception of herbicides and pesticides. The publication of Rachel Carson's *Silent Spring* in 1962 is often touted as the beginning of this change in perception and increased public understanding that herbicides and pesticides had effects other than those intended. The potential for herbicides and pesticides to be carcinogenic, mutagenic, toxic to human and animal reproduction, bioaccumulative and persistent in the environment, meant that biocontrol research gained greater appeal.

The decision to allow the introduction of biocontrol agents under the Plants Act was delegated to the Director of the Entomology Division at the Department of Scientific and Industrial Research (DSIR). The process involved was minimal, the scientist wrote a letter proposing an introduction, and the Director either agreed or disagreed with the proposal.

Later the decision-making power moved to the Chief Plants Officer of the then Ministry of Agriculture and Fisheries (MAF), who maintained this role until the new organisms functions of the Hazardous Substances and New Organisms Act (HSNO Act) 1996 came into force on 29 July 1998.

The HSNO Act Regime

The HSNO Act regulates all new organisms, including genetically modified organisms, requiring an application to be made to import into containment, develop or release any new organism. New organisms include all organisms that were not present in New Zealand prior to 29 July 1998. Therefore, new exotic biocontrol agents must gain approval for release under the HSNO Act.

The HSNO Act has changed the way that biocontrol agents are regulated in New Zealand by:

- imposing transparency on the decision-making process;
- removing political influence from the decision-making process;
- introducing the precautionary approach;
- combining genetic modification and biocontrol under the same legislation;
- requiring the applicant to provide evidence of risk and benefits; and
- imposing an application fee.

"... we have got very specific legislation that was not there before so it is restrictive in that sense. The requirements are totally defined, before there was not specific legislation that you had to comply with for new organisms."

Barbara Barratt, AgResearch

Regulatory imposed transparency

The introduction of the HSNO Act meant that from 29 July 1998 ERMA New Zealand must consider all introductions of new organisms, including biocontrol agents. In order for a new organism to be introduced and used for biocontrol in New Zealand, it must be approved for release.

The HSNO Act put in place regulation where previously minimal regulation existed, and reflected the change in societal norms and expectations.

The HSNO Act imposes a combination of statutory timeframes, specific decision-making criteria, independent decision-makers and capacity for public participation. All of which has resulted in a high level of regulatory imposed transparency. All decisions are publicly notified, and available to the public through the ERMA New Zealand website, along with application documentation and agency advice. This will allow future generations to understand why decisions were made, and what considerations were taken into account.

The New Zealand public expect and value the level of transparency and independence of the HSNO Act regime.

"One of the benefits of the transparency is that decisions are documented noting contemporary concerns. So in the future it is going to be much easier to see why decisions were made, and what was considered and what wasn't considered."

John Charles, Plant and Food Research

"I think it is very clear now, if someone were to ask the question, 'how was this decision made?' Everything is written down, it's all really clear, you can see exactly how the decision was made."

Lynley Hayes, Landcare Research

Statutory timeframes

The HSNO Act specifies timeframes within which applications must be considered, and decisions must be notified. Applicants view statutory timeframes positively because they give a level of certainty that a decision will be made.

Statutory timeframes are not a common feature in regulation of biocontrol in other countries.

"We are actually the envy of the rest of the world, because we have such a damn good system. I certainly think it is. It is well regulated, has specific timelines, and it has very specific guidelines as to what it can adjudicate on. No one else in the world has that available to them, which is why we are one of the few countries in the world still introducing or releasing biocontrol agents."

Hugh Gourlay, Landcare Research

Specific decision-making criteria

The HSNO Act specifies information that must be included in the application, matters that must be taken into account in the decision-making process and minimum standards that must be met in order for an application to be approved. This clear decision-making criterion provides a framework for fair and consistent assessment of applications to introduce new biocontrol agents.

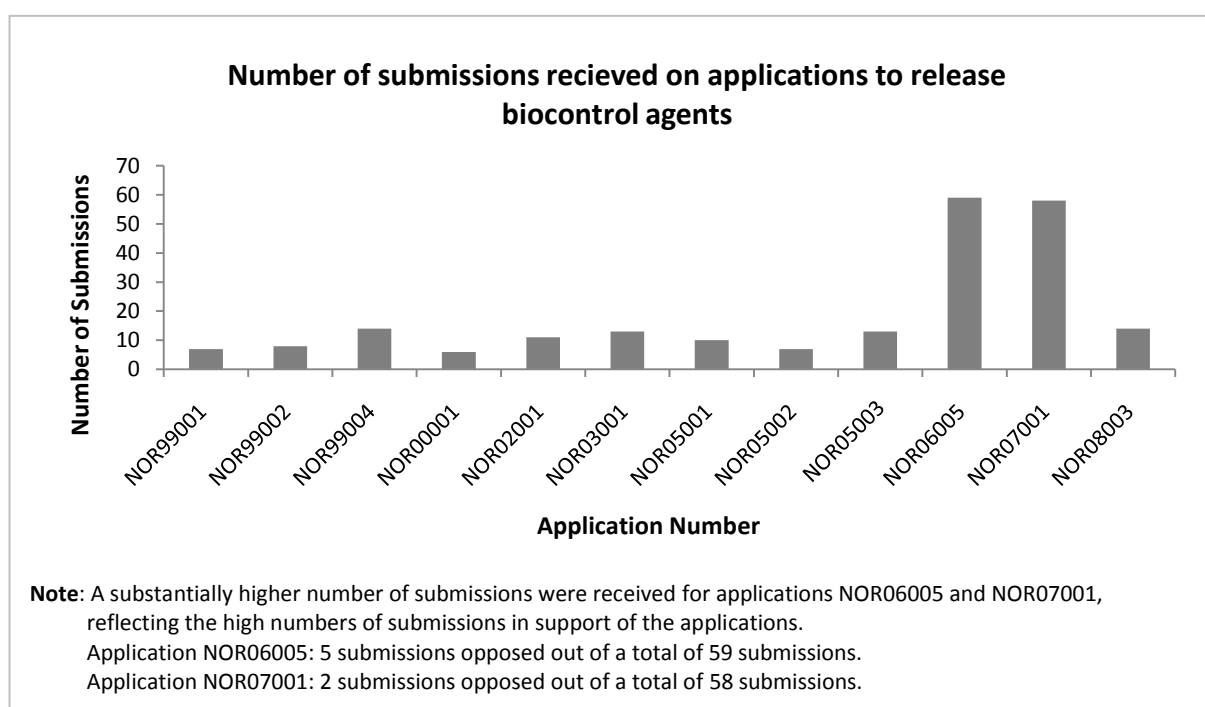
Public process

The HSNO Act lays out requirements for public involvement, through a public consultation, notification, submission and hearing process.

Previously, MAF determined, implicitly or explicitly, whether the importation was in the public interest, and gave permission to release. There was no explicit mechanism for evaluating the public interest, or allowing for public scrutiny or public comment.

Applications for releasing biocontrol agents under the HSNO Act must be publicly notified. This allows for public input into the decision-making process through submissions, and a public hearing, where required. Public hearings allow submitters to speak to the decision-making committee regarding their submission, and allow the applicant to respond to questions raised by submitters and the decision-makers.

The numbers of submissions received relating to applications for the release of biocontrol agents have been relatively low, averaging 18 per application. However, those individuals or groups who engage in the process value the ability to have their concerns recorded.



The inclusion of the public in the decision-making process under the HSNO Act reflects the desire of people to be involved in decisions that affect them, and is an integral part of a contemporary democratic society.

“The other thing we must say – the public consultation, it is quite costly, but it is all made public, if people don’t have their say, then frankly it’s their fault isn’t it. The whole system does seem to function pretty well.”

Simon Fowler, Landcare Research

Independent decision-making

The HSNO Act establishes the Environmental Risk Management Authority (the Authority), a quasi-judicial decision-making body. The Authority consists of six to eight members appointed by the Minister for the Environment.

Authority members are not necessarily experts in biocontrol, and some see this lack of knowledge and experience as a weakness. The Authority members are however, advised by the Agency and may obtain advice from external experts in fields relevant to applications.

To ensure that decisions would be independent of political influence the Authority was established as an autonomous Crown entity. In addition, the HSNO Act specifies that the Minister may not give direction to the Authority relating to any power, duty or function carried out under Part 5 (Assessment of hazardous substances and new organisms) or Part 6A (Group standards) of the Act. This independence of decision-making is a strong point of difference from other countries, where decision-making remains within the scope of government departments.

Independence of decision-making is also a key factor in the continuing introduction of biological control agents into New Zealand. In other jurisdictions where decision-making is entwined in the government, the processes are often hampered by political considerations. As a result, it appears that very few biological control agents are being introduced into countries such as the United States of America.

The independence of the decision-making process is a key factor in the confidence the researchers, applicants and submitters currently have in the regime, and has ensured that decisions can be made.

"Compared to Australian system for GM for example, they have an expert in the field making the decision, and here we have an Authority whose expertise is not necessarily in the field of biological control making the decision."

Sonia Whiteman, Horticulture New Zealand

"... ERMA is a quasi-judicial type body and is therefore free from overt political influence. As far as I know, all the other national systems, no matter where they are and how many items they process, all basically are handled by a government department, which then goes and seeks the views and approval from other government departments. I think that the whole process has basically ground to a halt in the US, and they just don't have rigorous politically independent system for genuinely assessing risk. I don't know whether the old system in MAF here would have suffered the same problem, but I would not be surprised if it did."

Simon Fowler, Landcare Research

"They (Australia) haven't slowed down as much as the US, but they are facing the same issues. Also, something that has come up recently is they have got gaps, so nobody tests for disease in insects over there for example."

Quentin Paynter, Landcare Research

"My understanding is that in the United States and Hawaii, they have got so risk averse that they don't seem to be able to make decisions anymore."

Lynley Hayes, Landcare Research

Approach to risk and uncertainty

The HSNO Act is inherently precautionary. A high level of precaution is inferred in the wording of the HSNO Act. For example, the purpose of the HSNO Act is to “*protect the environment, and the health and safety of people and communities, by preventing or managing the adverse effects of [...] new organisms*”. This assumes that all new organisms will be harmful to the environment, which does not align with the use of biological control agents that are generally intended to be beneficial to the environment.

“The HSNO Act is about risk aversion, so how risk averse do you want to be? Certainly my experience is that the level is very high.”

John Charles, Plant and Food Research

Likelihood of exposure

There is a perception that the HSNO Act is at odds with the Biosecurity Act 1993 with regard to the level of accepted risk. This is because the HSNO Act deals with deliberate introductions, where there is an absolute certainty that the environment will be exposed to the organism in question. In contrast, the Biosecurity Act is concerned with the potential for unintended introductions, where the likelihood of exposure of the environment is significantly lower. This leads to frustration in potential end users of biocontrol, particularly in small industries who are affected by pest incursion.

“As an industry we experience first-hand what seems like two different approaches from when it comes to protecting our industries from new incursions versus access to pest management options, often for incursions. The Biosecurity Act approach is that ‘there is no such thing as nil risk, we issue import health standard on produce and do our best to remove and avoid any new organisms/pests, but trade has to go on’. The HSNO Act approach is that ‘if there is a high level of uncertainty or any potential for adverse effects then it will not be allowed in’. So growers feel like on one hand it seems easy for the bad stuff to get in, but on the other hand it is too hard to get the good stuff in. Our growers would probably feel better if it was a level playing field – with a consistent approach.”

Sonia Whiteman, Horticulture New Zealand

Minimum Standards

The HSNO Act specifies minimum standards that must be met in order for an application to be approved, relating to ‘significant’ effects on native species, natural habitats, human health and safety, and genetic diversity. The HSNO Act does not define what constitutes a ‘significant’ effect and the applicant community remains unsure about how the Authority will respond to any potential for adverse effects resulting from a biocontrol agent.

Researchers believe that if there is any potential for adverse effects to result from the introduction of an agent, the application will be declined, regardless of the potential benefits. Consequently, researchers tend to take a very conservative approach, choosing to investigate those potential agents that are most likely to meet the HSNO requirements, ie those with no potential adverse effects.

“I think there is a lack of clarity around the minimum standards and what the interpretation of a significant impact is. I think that the policy documents should state actual numbers because there is far too much potential for interpretation around some of the statements in the minimum standards. They’re being applied in a very prescriptive manner, but they are not written in a quantitative fashion.”

Sonia Whiteman, Horticulture New Zealand

Increased perception of risk

The HSNO Act brought the regulation of hazardous substances, genetically modified organisms (GMOs), zoo animals, plants and biocontrol agents into the same regulatory regime. The perceived linking of genetic modification and biological control has resulted in biocontrol being treated with the same degree of caution as genetic modification. As a result, many view the HSNO Act and the decisions made under the HSNO Act, as being excessively restrictive and risk averse towards biocontrol.

This is challenging for researchers and potential users of biocontrol as they face the regulatory hurdles imposed by the HSNO Act and increased wariness from the public.

"Grouping non-GM and GM together under the same legislation just doesn't make sense to us. Given the public perception we can't understand why the GM and biological control agents would be assessed in the same way."

Sonia Whiteman, Horticulture New Zealand.

"...it isn't the same as GM, and right from the word go that has been one of the major concerns that biocontrollers have had with the HSNO Act. It has brought biocontrol agents into the same arena as hazardous substances and genetic modification. It's always been a bad fit, because the HSNO Act is there to prevent stuff from escaping and breeding, and with biocontrol agents that is precisely what you want them to do."

John Charles, Plant and Food Research

Level of uncertainty

The HSNO Act requires that the Authority take a precautionary approach in managing adverse effects where there is scientific and technical uncertainty about those effects. The level of certainty that is required for an application to be approved is not defined in the HSNO Act or Methodology. Therefore, the decision-maker must determine what level of uncertainty is acceptable to them.

Biocontrol involves the introduction of living organisms into the environment, and the effects of this cannot be predicted with absolute certainty. The level of uncertainty that the decision-makers will accept is directly related to the level of information required in the application and accuracy of that information. This is challenging for researchers, as they must provide comprehensive information about host-range and potential non-target effects, which comes at a very high cost. However, applicants do not want to risk reaching the consideration stage of the decision-making process and being asked to carry out further information, or having an application declined. Consequently, applicants may undertake more research than necessary without significantly increasing certainty of the outcome.

"... sometimes the questions being asked can't really be answered. I felt that some of the stuff ERMA wanted to know was quite hard to answer, like what is its' host range going to be in the field – we can't tell you, we can only tell you what we estimate it is going to be."

Stephen Goldson, AgResearch

"I think that probably is the most difficult step in introducing a new biocontrol agent – making predictions on bio-safety. All research has difficulties but that's one that's got the greatest level of uncertainty around it and it's a major part of introducing a biocontrol agent into New Zealand."

Barbara Barratt, AgResearch

Impact of regulation on research

The HSNO Act has formalised the process of considering the risks and benefits of introducing a new biocontrol agent, incorporating information requirements based on best practice into the decision-making process.

An organism may be approved for release only if the positive effects of releasing the organism outweigh the adverse effects of the organism and any inseparable organisms. The onus is on the applicant to provide sufficient evidence that the benefits of the biocontrol agent outweigh any potential adverse effects of its introduction. The applicant must also show that the potential adverse effects of the organism on native species, natural habitats, human health and safety, and genetic diversity will not be significant. Therefore, the legislation has influenced the amount and direction of research for biocontrol programmes in New Zealand.

For biocontrol, adverse effects generally relate to non-target effects on native or valued introduced fauna and flora, and indirect effects on the ecosystem, food webs and disease.

“HSNO has improved the need for science – because of the [environmental] requirements; it has meant that we have to do more science to demonstrate the safety. Perhaps in the past there was a level of assumption there, but under the Act you have to demonstrate rather than assume. That is actually a good thing, but it means that more work is required which costs more. The increased science requirement of the HSNO Act hasn’t been matched with increased funding. That has made life difficult.”

John Charles, Plant and Food Research

Host-range testing

Host-range testing is a fundamental part of biocontrol research. It is used to determine whether the agent will be effective against the target and if any non-target effects are likely. The level of host-range testing involved in researching potential biocontrol agents has increased as people became more aware of potential non-target effects, and put greater value on native species and ecosystems.

At the time the HSNO Act was being developed, best practice was also evolving, and the HSNO Act incorporated best practice policies into the regulation.

“Globally there is far more awareness of the dangers of non-target effects. I think scientists engaged on biocontrol now would probably self-regulate to some extent anyway if we hadn’t got the HSNO Act I think we would have been following European type models anyway.”

Barbara Barratt, AgResearch

“I think the science is keeping up with the Act, or the Act is driving the science, either way the science is at a level with what the Act is demanding. I don’t think that it is restrictive in that sense.”

Lisa Berndt, Scion

“We are probably doing more [host range testing] than we were in the past, although we were doing increasing amounts as HSNO evolved, because we are good citizens and don’t want to take short cuts, or do anything wrong.”

Stephen Goldson, AgResearch

“The HSNO Act is making us do this, but we are actually more science savvy now than we were 10 years ago. New Zealand has been leading the world in a number of these areas, but we are much more savvy about parasitism of potential biocontrol agents, impacts of potential biocontrol agents. There are non-target impacts, food-web impacts, and things like that. I think we look a great deal more, and what we want to look for now is agents that have a greater potential to have a greater impact.”

Hugh Gourlay, Landcare Research

Test species selection

In selecting the appropriate range of species for host-range testing it is essential that all potential non-target organisms are identified. The public now expects native and valued introduced species to be included in the test species list. In many cases, the inclusion of a number of native species is appropriate and scientifically valid. In some cases, however, inclusion of a wide range of native and/or crop species is not scientifically justified and little or no value is gained from including native species, unrelated to the target, in the host-range testing regime.

In some countries, such as Australia, government departments have an active role in selecting the non-target species for host-range testing. Governmental input into the host-range testing planning has the benefit of giving the researchers a comprehensive species list at the early stages of the research. Therefore, researchers will not get to the application stage and be required to carry out further testing. However, this can also result in the inclusion of many crops and other species that may not be indicated as being at risk. The consequence of this is the researchers must undertake a much larger host-range testing programme than may have been necessary, increasing the time and cost of completing the research programme.

There is no formal requirement under the HSNO Act to have a test species list approved by ERMA New Zealand or any other government agency. However, ERMA New Zealand advises potential applicants to discuss potential biocontrol agents and the associated host-range testing programmes with the Ministry of Agriculture and Forestry (MAF) and the Department of Conservation (DoC). ERMA New Zealand also encourages applicants to make early contact with the agency for pre-application discussions.

"The Australians have to work under an approved, by the MAF/DOC equivalent, test plant list, which is highly subject to politics and vested interests etc, so their lists are always enormous. It is hugely costly!"

Richard Hill, Richard Hill & Associates

"We are working currently on a joint project with Australia – for Chilean needle grass. [...] Based on the host range testing that has been done we believe we can make a case right now to bring it into New Zealand. But the Australian authorities are requiring them to test a huge number of additional plants which is coming in at an enormous cost. The Australians are running out of money and they haven't finished all the testing – this is the type of thing that can cause a project to fail.

They have had a lot of releases over there, but their system has slowed right down. It has become much more difficult. They are still not able to grasp that you can test a lot fewer species and not make it more risky. It is a huge additional cost."

Lynley Hayes, Landcare Research

Weed biocontrol testing

There is a widely accepted rationale for estimating the host-range of phytophagous (plant eating) biocontrol agents, including a widely accepted method for selecting test species. This rationale has been tested against the HSNO Act decision-making through a number of applications. As a result, weed biocontrol researchers are comfortable with the range and level of host-range testing that they need to do in order to meet the information requirements of the HSNO Act. There is also a consensus that the level of host-range testing required by the HSNO Act is very similar to the level of testing that the researcher would want to be doing regardless of the regulation.

Invertebrate biocontrol testing

The host-range testing rationale for entomophagous (feeding on insects) biocontrol agents (parasitoids and predators) is often considered more complex than that for weed biocontrol agents. This is mainly because of the additional trophic layer involved, and the difficulty in inoculating test organisms with eggs or neonates (newly born) life stages of the agents. In addition, in order to test susceptibility of native species it is necessary to either rear those species in containment or collect large numbers from the wild in order to carry out robust testing. Knowledge of native species is often poor, and there are many species that have not been identified or well studied, therefore these organisms may be difficult to source and technically very difficult to rear in containment.

There is no widely accepted rationale for selecting test species and the level and range of host-range testing required by the HSNO Act for invertebrate pest biocontrol agents has not been put to the test. This is, because so few applications have been considered for these types of agents. Consequently, researchers tend to feel that they need to extend their host-range testing to organisms beyond what they consider scientifically robust, in order to meet the requirements of the HSNO Act.

It is likely that it will take a number of years and applications for releases of invertebrate pest biocontrol agents before a balance is reached where the researchers are comfortable that their rationale for the scope of host-range testing will be accepted by the Authority.

“Just because it is rare and endangered, doesn’t mean it is at any more risk than anything else.”

Richard Hill, Richard Hill & Associates

“In my experience you don’t want to waste people’s time by doing that (application without extra host range testing). We have tended to feel that we have got to accommodate the Act and be proactive and deal with that rather than testing the Act to the limit by putting in an application with ‘minimal’ information.”

John Charles, Plant and Food Research

Consideration of natives

The HSNO Act formalised concern for native species, natural habitats and New Zealand’s inherent genetic diversity.

While in the past detrimental effects on native species may have been known, they were not a significant factor in making a decision to introduce an agent. In fact, feeding on any non-target species could have been considered an advantage, if it were to help an agent establish or survive while the target pest was not in abundance.

In the past, some biocontrol agents were introduced with the intention of targeting native species. Under the HSNO Act, a new organism cannot be approved for release if it does not meet the minimum standards, including if it were likely to cause significant displacement of any native species within its natural habitat. This means that biocontrol agents targeting native species could not be approved for introduction under the HSNO Act, unless it could be shown that they would not affect that native species in its natural range.

“For many years a parasitoid that fed on a non-target host was actually viewed as a good thing, because that would allow it to breed continuously through the year when maybe the host was in diapause or something. The science was there and people knew what was going to happen – it was just perceived differently.”

John Charles, Plant and Food Research

Biological control for native grass grub

The conversion of large areas of New Zealand into pasture provided favourable conditions for some native pests such as grass grub (*Costelytra zealandica*).

Costelytra zealandica larvae feed on the roots of grasses, making it one of the most important pasture pests in New Zealand. DDT was used to treat this pest until insecticide residues and resistance prompted interest in alternative treatments including biological control. A number of potential biocontrol agents have been imported and released since 1921, including parasitoids, predators, and nematodes. Failure to establish, or difficulties with rearing in the laboratory resulted in those agents having little or no success.

The current method of controlling *C. zealandica* is a 'bio-pesticide' containing a high density culture of the bacterium *Serratia entomophila*, which is available in a number of different commercial preparations.

Types of organisms being investigated for use in NZ

There is some concern that the HSNO Act is limiting the types of organisms that are investigated for use in New Zealand, and as a result, New Zealand may be unable to gain the benefits of different types of biocontrol agents.

The HSNO Act does not explicitly limit the types of organism that can be considered for biocontrol. However, the requirement for consideration of effects on native and valued species and ecosystems, and the requirement for the applicant to provide that information, does limit the organisms that are likely to be approved.

Generalist biocontrol agents

Generalist or polyphagous organisms are those that feed on different species, or, more commonly, different families. Biocontrol agents that are likely to feed on, parasitize or otherwise have detrimental effects on multiple species are unlikely to be approved under the HSNO Act. This is because they are more likely to cause adverse effects on non-target species. Polyphagous biocontrol agents are also less likely to be selected for a classical biological control programme because they are unlikely to be as effective at reducing the target pest because they can feed on/parasitize other organisms.

However, polyphagous characteristics may be seen as advantageous for augmentative biocontrol, as it would allow the use of one agent to target a range of pests. For example, *Macrolophus caliginis* is used in tomato and eggplant greenhouses to control whiteflies, but it also attacks spider mites, and is commercially available in Europe (Biobest). (also see page 32 for more information about *M. caliginis*)

"Which parasitoid or which natural enemy to introduce has always been based on the science and the biology of interactions between the target organism and the natural enemy..."

The reality is that polyphagous parasitoids, on the whole, are not seen as being the most effective parasitoid in any circumstance. So polyphagy, from a scientific perspective is almost immediately a reason for discarding a choice of a parasitoid – on science grounds, not on HSNO grounds."

John Charles, Plant and Food Research

Microbial biocontrol agents

Microbial biocontrol agents have the potential to be used against invertebrate pests, plant pests (weeds) and pathogens. There have been no applications to release microbial biological control agents under the HSNO Act.

Landcare Research is not carrying out any work on new organism microbial biocontrol agents for weeds within New Zealand, but is contracting host-range testing work to be carried out offshore. One of the reasons for this is that there are currently no containment facilities (glasshouses) approved for plant and pathogen work at the scale required. To complete host-range testing of weed biological control agent the agent needs to be tested against growing plants at various life stages. In order to do this in containment, the containment facility must be suitable to contain both the adult plants and the microorganisms.

Commercial biocontrol products comprising of microbes that are present in New Zealand, such as *Trichoderma sp.*, are being research and developed in New Zealand. These products are not regulated new organisms under that HSNO Act, but may require approval as a hazardous substance.

Many researchers consider that microbial biocontrol agents have the potential to be very effective, but some are cautious about the limited knowledge around the potential effects of microorganisms.

"The reason you haven't had any applications for pathogens is because the work that has to be done has taken longer, there are a number ready to go – if we raise the funds."

Lynley Hayes, Landcare Research

"One of the issues is that it's still unclear as to what would actually be required for a containment facility. It's been an ongoing conversation that we keep trying to have with ERMA and MAF, and no one really wants to make a decision as to what level of containment would be required."

Sarah Dodd, Landcare Research

"Many of our weeds do not have any invertebrate pests specific enough to be considered as biocontrol agents. In many cases pathogens can be more specific and highly targeted to plant pest species."

Hugh Gourlay, Landcare Research

Regulatory imposed costs

The HSNO Act places a high financial burden on applicants, through the introduction of an application fee, and indirectly through the high information and consultation requirements.

The overall costs of biological control programmes mean that biocontrol is not a financially viable option for pest control for many small industries.

Application costs

ERMA New Zealand charges an application fee for all applications considered by the Authority. Prior to the HSNO Act no application fees were involved in introducing new biocontrol agents.

The application fee for conditional release applications is negotiable. The ERMA New Zealand fee for release applications was reviewed, and reduced from \$33,750.00 to \$16,875.00 plus disbursements on 1 July 2009. The disbursements aspect of the fee has raised some concerns with potential applicants who fear the potential extent of those uncapped costs. This makes it very difficult for applicants to budget for the HSNO application aspect of a biocontrol programme.

"The \$30,000 ERMA fee is actually a small part of it. The most significant cost is in the host range testing. We have a current programme underway for a psyllid biocontrol agent and just to do the initial testing we are looking at about \$0.5 million, and on top of that you've got the application preparation, a consultant has quoted us \$30-40,000 to do this."

Sonia Whiteman, Horticulture New Zealand

"The fees do cause delays. At the moment we have a Chilean needle grass agent ready to go, one lantana agent ready to go and another that we have just finished testing. But we have to try and raise the funds for ERMA fees and for the application preparation. So that means those are going to sit around until the next financial year until we have more money or more financial support. So it is a big hurdle to raise \$70,000."

Lynley Hayes, Landcare Research

"Growers and grower organisations – everybody resents paying fees. \$30,000 on top of what they are contributing to the science is considered a lot of money."

John Charles, Plant and Food Research

The application fee is generally a small portion of the overall costs of a biocontrol programme, however it can be a substantial burden on the applicant as it is a cash out-lay, and would not be covered by research funding grants.

There are also substantial additional costs involved including preparing the application, carrying out pre-application consultation, and attending a hearing if one is held.

"In terms of preparing an application, at the moment we pay someone to prepare the application, plus we have some costs ourselves – if we have to attend hearings, our time to assist with information, pre-application consultation, and if we have to go to a hui. Currently the costs of application preparation for weed biocontrol agents are around \$35-\$40K."

Lynley Hayes, Landcare Research

"The amount of information, and the way the information has to be presented and concerns about the cost of Maori consultation could be prohibitive. Essentially, once upon a time, the researchers would do their work; and say this 'looks good, let's bring it in'. Now the information has to be massaged into a particular format, publicly notified, and potentially presented at a hearing. This all costs and industry receives no added value for that. This is a process we could do without, and money that we could spend more productively elsewhere."

Sonia Whiteman, Horticulture New Zealand

Cost of information

The HSNO Act requires the Authority to consider the risks and benefits of the organism, and it is the responsibility of the applicant to provide information about those risks and benefits. The acceptable level of uncertainty about potential effects dictates the level of information needed in an application. If an applicant provides insufficient information and the Authority is unable to assess the adverse and beneficial effects, the application will be declined.

The cost of gathering sufficient information to fulfil the HSNO Act requirements varies depending on the agent, and how much information is available about the agent, the technical difficulties that arise during the host-range testing (including rearing the agent, and rearing target and non-target organisms for testing). Programmes can range from \$500,000 to several million over a period of years depending on the extent of host-range testing required and technical difficulties encountered.

“There is a great cost associated with reducing the uncertainty, with diminishing returns. If you want a low level of uncertainty it costs a heap more than if you want a reasonable level of uncertainty. We can do cheap and cheerful, which will give plus or minus 10%, or for 5 times the cost, we’ll get it to plus or minus 7%. So there is some limits to what reasonably can be asked if moderate amounts of money are going to be spent, and there is a kind of judgement in there somewhere.”

Stephen Goldson, AgResearch

“It makes it more expensive than it used to be – before HSNO. So yes, there is certainly an increased cost associated with the process. It was initially (a negative) for us, we had no applications for biocontrol agents for several years after ERMA was formed really because none of our projects could afford that cost associated with the application process.”

Hugh Gourlay, Landcare Research

“The cost of host range testing can vary enormously depending on whether or not the results are straight forward. We are working on a banana passion fruit agent which is becoming incredibly expensive to test because we have got to a situation where we have to do field tests in the native range.”

Lynley Hayes, Landcare Research

Researchers are often under pressure to provide results for lower cost programmes, which the researcher is able to counter with the rigorous requirements of approval under the HSNO Act. In such situations, the HSNO Act is justifying the cost and need for comprehensive research to funding bodies, clients and end users and thus ensuring better science.

“...because there is such a financial driver. If we have an industry or a customer wanting an agent introduced, they want to do that in the least possible time and money essentially. Our driver might be to do the best science, but there is always the “well you don’t have enough money”. So it gets squeezed and squeezed. By having a regulatory bar to jump over, you can then say to your clients “well that is what we’ve got to do – it’s got to be to this level – it’s not just because we want to do more science”. It’s hard for us to argue that we need to do that much unless there is a reason for it.”

Lisa Berndt, Scion

“We would do exactly what we do now anyway – for best practice. The amount of preparation work we do, we would do anyway, because it is what we need to do to be confident that the agent is acceptable.”

Lynley Hayes, Landcare Research

Cost of consultation

All consultation carries a cost, taking up time of applicants and researchers, and in many cases travel and preparation of targeted information.

Consultation with Māori

Māori consultation, in keeping with taking into account the Treaty of Waitangi (Te Tiriti o Waitangi), is an integral part of the pre-application process for all release and conditional release applications. This represents costs in terms of time and money, which increases with the level of engagement from those parties being consulted. In some cases, one or more hui are held, or consultants are employed to facilitate or complete this process.

Applicants often find the consultation process challenging and somewhat imprecise with varying levels of engagement from Māori. As a result, some applicants find little value in the consultation process, while others find it benefits their research and application preparation.

ERMA New Zealand has not surveyed the Māori network/community regarding their view of the consultation process relating to the introduction of biological control agents. However, it has been noted that concerns raised by Māori regarding recent applications are consistent with issues discussed at the Biological Control Agents Wānanga held in 2005. In addition, non-Māori submitters also raise similar concerns.

"We have this process (Maori consultation) that has the potential to blossom and potential to blossom out of control. I guess from my point of view it would be nice if it was more of a precise system."

Hugh Gourlay, Landcare Research

"The ability of iwi and hapu to comment on environmental issues like this is actually going ahead by leaps and bounds, and they are getting more and more able – resourced and staffed, to actually comment. I am expecting that as time goes by, instead of getting 10 or 12 responses from iwi, we are going to get 20 or 30. And they are all going to be considered responses that have to be dealt with, and dialogue that is going to have to be entered into. While everything is manageable at the moment, I can see a time when it would become unmanageable, and that would become very difficult and expensive for applicants."

Richard Hill, Richard Hill & Associates

Consultation with government agencies

ERMA New Zealand recommends applicants under take some form of consultation or discussion with MAF and DoC in the early stages of their research, and when preparing the application. This may include discussions around host-range testing species list, use of biocontrol agents in the conservation estate, potential for associated organisms and biosecurity concerns.

Consultation with industry and other interested parties

ERMA New Zealand recommends applicants gain the support of the intended end-users prior to submitting an application to release a new biocontrol agent. This is typically an integral part of a biocontrol programme as a biocontrol programme is unlikely to gain funding without support of the end-user. ERMA New Zealand also recommends that applicants communicate with other interested parties who may be indirectly affected by the introduction of a biocontrol agent. This can be helpful in dealing with concerns prior to the public hearing stage of the process.

"I think we can over consult about things, particularly with people who don't know what you are doing. The science community is stretched enough as it is."

Stephen Goldson, AgResearch

Approvals for biocontrol agents

Applications declined

No applications to release biocontrol agents have been declined by ERMA New Zealand. This has most likely resulted from a combination of thorough pre-application discussions with applicants, and active decisions by researchers not to pursue any agents that are not obviously going to meet the minimum standards.

"I think if anything is turned down [under HSNO] it means that the applicant hasn't engaged."

Barbara Barratt, AgResearch

Applications approved

To date twelve applications, covering seventeen organisms for release, or conditional release, have been approved for the biocontrol of nine plant pests (weeds) and three invertebrate pests. Two applications were for release with controls or "conditional release"; all other applications were approved without controls.

Approvals for release with controls

The two HSNO Act approvals for release with controls both have controls limiting the source of the populations that may be imported and released in New Zealand to the specific populations that had been host-range tested.

It has been suggested that all releases of biocontrol agents should be 'conditional', with the requirement that only those geographic populations that have been host-range tested and shown to have the appropriate level of specificity may be imported and released. This has eventuated because unanticipated non-target impacts have been observed in some situations where different biotypes were released.

Evidence based controls

ERMA New Zealand currently considers that such controls are only appropriate in situations where there is evidence of risk. For example, where there is evidence of biotype differences or geographical separations that suggest there could be biotype differences. In such cases, if there is no evidence to show that all populations carry the same risk, a control could be imposed to limit the populations approved for introduction to those that have been tested and shown to be safe. However, such a control would not be necessary in all situations.

Gorse pod moth – biological control for gorse

In 1990s, prior to the HSNO Act, gorse pod moth (*Cydia succedana*) was released in New Zealand for the biocontrol of gorse. The introduction was, based on host range testing of moths collected from southern England.

It was discovered that, contrary to expectation, gorse pod moth was also attacking several exotic Genisteae and Loteae species. The subsequent investigation determined that the unpredicted attack was not due to the importation of a cryptic species. Specificity tests on populations from England were consistent with initial research, however testing of populations from Portugal, also released in New Zealand, showed a broader host range. It was also observed that there is poor synchrony between the adult gorse pod moth and gorse flowering, although gorse is the preferred host (Paynter et al, 2008). As a result it is now best practice in New Zealand that biological control releases be made up only of the same geographic populations as those agents that were thoroughly host tested.

Applications for the release of biological control agents approved under the HSNO Act

Application	Applicant	Agent(s)	Target Pest Organism
NOR99001	Hawke's Bay Pipfruit IFP Group 20	<i>Pseudaphycus maculipennis</i> (parasitic wasp)	Mealy bug
NOR99002	New Zealand Citrus Growers Incorporated	<i>Thripobius semiluteus</i> (parasitic wasp)	Green house thrips (<i>Heliothrips haemorrhoidalis</i>)
NOR99004	Auckland Regional Council	<i>Procecidochares alani</i> (insect gall fly)	Mist flower (<i>Argeratina riparia</i>)
NOR00001	Hieracium Control Trust	<i>Macrolabis pilosellae</i> (hieracium gall fly), <i>Cheilosia urbana</i> (root feeding hover fly), <i>Cheilosia psilophthalma</i> (crown feeding hover fly)	Hawkweeds (<i>Hieracium</i> sp)
NOR02001	New Zealand Forest Research Institute (trading as Scion)	<i>Cleopus japonicas</i> (buddleia leaf weevil)	Buddleia (<i>Buddleja davidii</i>)
NOR03001	Environment Canterbury	<i>Tortrix</i> s.l. sp. "chryanthemoides" boneseed leafroller	Boneseed
NOR05001 (conditional release)	AgResearch Limited	<i>Microctonus aethiopoides</i> (parasitic wasp)	Clover root weevil
NOR05002	West Coast Ragwort Control Trust	<i>Cochylis atricapitana</i> (ragwort corn borer), <i>Platyptilia isodactyla</i> (ragwort plume moth)	Ragwort
NOR05003 (conditional release)	The Canterbury Broom Group	<i>Agonopterix assimilella</i> (broom shoot moth), <i>Gonioctena olivacea</i> (broom leaf beetle)	Broom
NOR06005	Californian Thistle Action Group	<i>Cassida rubiginosa</i> (beetle), <i>Ceratopion onopordi</i> (weevil)	Californian thistle (<i>Cirsium arvense</i>)
NOR07001	Auckland Regional Council	<i>Neolema ogloblini</i> (beetle)	Tradescantia (<i>Tradescantia fluminensis</i>)
NOR08003	Environment Bay of Plenty	<i>Gargaphia decoris</i> (woolly nightshade lacebug)	Woolly nightshade (<i>Solanum mauritatum</i>)

Power to impose controls

To date controls have not been imposed on applications that have been made under the full release provisions of the HSNO Act. There is provision within the HSNO Act for the Authority to impose a control on a full release application, with the consent of the applicant.

Researchers are hesitant to make applications under the conditional release provisions of the HSNO Act. This appears to be due to concerns about the potential for the Authority to apply controls that the scientists do not think are necessary, limit their ability to use the organism to full benefit, or impose additional costs on them. This highlights the importance of having robust reasoning behind all controls imposed by the Authority, which will allow the scientists to gain confidence that the Authorities decisions are well founded.

“Conditional approvals should be given to the people who have the expertise, have done the work, and know where the populations exist. If you can’t do that because it gives an unfair economic advantage to a particular group then I don’t see the reason why you would bother [applying for a conditional release].”

Hugh Gourlay, Landcare Research

“There is hesitancy around making a conditional release application because the Authority could add other controls.”

Barbara Barratt, AgResearch

Practicality of controls

Auditing and enforcing compliance with controls can be very challenging. For example, enforcement of controls relating to country or location of origin relies on the honesty of the importer, making compliance difficult to verify. Therefore, it is feasible that someone could import agents from a different location, if they were to make false declarations.

“If somebody really wanted to smuggle in an M. aethiopoides from somewhere in Europe, not from Ireland and not parthenogenic, then they could probably do that quite easily.”

Barbara Barratt, AgResearch

One option to decrease the risk of this occurring would be to limit the importation of the agent to the research group that carried out the host-range testing. There is a small concern that this would give the group a commercial advantage, however the biocontrol research community in New Zealand is very small and conflicts are unlikely to arise.

***Microctonus aethiopoides* (Irish) – biological control of clover root weevil**

Sitona lepidus (clover root weevil) is a significant pasture pest in New Zealand, causing damage to clover through larvae feeding on root nodules and adults feeding on stems and leaves.

Microctonus aethiopoides (a small parasitic wasp) lay eggs in the abdominal cavity of adult clover root weevils, and kill the weevils as the prepupal stage emerges. An Irish parthenogenetic (reproduces without fertilization of the egg) strain of *M. aethiopoides* was chosen for introduction into New Zealand for the control of clover root weevil. The Irish was selected because it is incapable of hybridising with the Moroccan biotype of *M. aethiopoides* that is used for the control of *Sitona discoides* (lucerne weevil).

A control was imposed on the HSNO Act approval for the importation and release of *M. aethiopoides* (Irish) requiring that users provide MAF with verification that the individuals to be released are parthenogenetic.

Effectiveness of decisions

The purpose of the HSNO Act is to protect the environment by preventing or managing the adverse effects of new organisms, and in this instance, we are focusing on new organisms that are biocontrol agents. How effective is the HSNO Act regime at achieving that purpose?

Seventeen biocontrol agents have been approved for release under the HSNO Act since 1998, and to date there is no evidence of any adverse effects on the environment resulting from the presence of those organisms. That means that no new organisms approved for release under the HSNO Act regime as biocontrol agents have resulted in adverse effects on the environment or the health and safety of people and communities. This infers that so far the regime is very effective at achieving its purpose.

However, effective agent establishment may take many years, and evidence of control of the pest may not be detected for 10 years after that, so no programme should be judged a success or failure until at least 10 years after the release of the last agent. In addition, working lives are short; consequently, few scientists involved at the start of a weed control programme are still involved when success is achieved, so the full extent of the success of a programme may not be appreciated (McFayden, 2000). The biocontrol agents approved for release under the HSNO Act have been in the New Zealand environment for a very short time, and it may take many years for any effects, beneficial or adverse, to be realised from those biocontrol agents. Therefore, a longer-term approach needs to be taken before conclusions can be drawn.

One of the biggest problems with measuring success and recalling success is that people forget the extent of the problem, or are unaware that a biocontrol agent was involved in the solution. Therefore, record keeping and a post-release research programme are essential in evaluating the effectiveness of biocontrol agents.

"If there is no monitoring, that is a huge opportunity lost. All those projects that have gone on in the past in New Zealand, where there have been releases but nobody really has a clue what's happened to them, how can you learn from that? The benefit to the science of biocontrol is to have overview information, so each project can contribute to a body of knowledge, and if each project doesn't do any monitoring then it is only half the story."

Lisa Berndt, Scion

Post release research

Researchers are interested in post-release research investigating a range of things including establishment and dispersal of the agent, efficacy of the agent against the target pest, non-target impacts, succession (replacement species), food-web changes and integration into pest management systems. This research can validate the host-range testing regimes undertaken by the researchers, and indicate where those regimes are not reflecting the real world outside the laboratory.

Submitters frequently raise the issue of 'monitoring' in their submissions, often requesting that monitoring be required as a condition of any approval. Through 'monitoring', they seek reassurance that any non-target adverse effects be limited through early detection and remedial action. However, under the HSNO Act, controls must be imposed for the purposes of controlling the adverse effects of the organisms on people or the environment. Post release monitoring for non-target effects does not mitigate a potential adverse effect, therefore it cannot be required as a condition under the HSNO Act.

In addition, post release research can only be useful if there is something to monitor, therefore if the agent does not establish, there is no logic in looking for non-target effects. For this reason, post-release research is generally carried out in a stepwise fashion, first looking at establishment, then, if possible looking at the wider picture. This would make enforcing and auditing of any controls requiring post-release research impossible.

A great deal can be learnt from post release research; however, it comes at a substantial cost, and funding is very limited. Funding for a biocontrol programme does not usually extend to a substantial post-release monitoring programme, particularly if a community group or small industry sponsors the programme. In addition, because it can take many years for a biocontrol agent to establish and reach numbers sufficient to have an impact, any post-release research must have a long-term plan and budget. This means that any funding available has to be prioritised between researching something that has been released, and researching a new agent that could solve a different problem.

ERMA New Zealand supports the carrying out of all post release research, in particular any research that can show whether the correct decisions have been made, and strengthen the decision-making process for the future. However, ERMA New Zealand is not in a position to fund any of this work.

“Monitoring would be nice to have so we could assess the benefits of our investment, however, it is a case of who is going to pay to do it and with other pests to manage, monitoring the past doesn’t really rate as a priority.”

Sonia Whiteman, Horticulture New Zealand

“From my perspective monitoring isn’t actually monitoring, it’s about measuring impact – on the pest that was the target. Because we routinely work with the industries that we work with – we’re constantly measuring pest impacts, our reason for being is to enable fruit industries to sell fruit off-shore and make money. When we release a natural enemy we are always able and trying to establish what impact it has in the future.

It is actually very difficult to work out a programme to monitor for non-target effects, and very expensive, so with mealy bug for instance, one of the things we are doing is to look at the dispersal of parasitoids out of exotic environment to see whether in fact they will go into the native bush. One of the ways you can do that is collect mealy bugs from the bush and rear out the parasitoids that are in the native mealy bugs. If there are any exotic mealy bugs, you know they have moved into the bush.”

John Charles, Plant and Food Research

Comparison with previous regime

The decision-making process

As mentioned earlier, the HSNO Act differs from earlier regimes in its transparency, provisions for public involvement and an independent decision-making committee. The HSNO Act requires an application to be made, publicly notified and considered by a committee, in contrast to previous regimes where decisions were made behind closed doors.

Ability of decision-maker to make decisions

The independence of the decision-making committee and specific decision-making criterion prescribed by the HSNO Act has made it possible for ERMA New Zealand to consider and make decisions on new biocontrol agents. It is very unlikely that this would have been possible under the previous regime, which was subject to government policy and influence.

Application fees

The HSNO Act differs from the previous regime in that it imposes a fee on the applicant. This was a big change for applicants who previously had not budgeted for this. Applicants also found that funding grants did not include application fees, meaning that the end user needed to raise this money, where previously they may not have contributed to research funds.

Decision-making criteria

In comparison with previous regimes, the HSNO Act is very prescriptive about the things that must be taken into account for approval to be given. Previously decisions were based on whether the agent was likely to successfully target the pest. Under the HSNO Act regime, the decision-maker must consider

the potential for adverse effects on native species and natural habitats. The formal consideration of potential adverse effects on native species and natural habitats is a reflection of the value that society now places on the environment.

Public good

There are some people who do not see any value in the HSNO Act regime, believing that researchers would 'self-regulate' in the absence of regulation. This may hold true from Crown Research Institute (CRIs) which are Government-owned businesses with a scientific purpose based around a productive sector of the economy or a grouping of natural resources. However, for private research and industry the financial drivers may be more influential than the greater public good.

"Most of us [Government researchers] have an instinct for trying to preserve what is left of biodiversity and the environment, so to some extent I think we wouldn't bring in generalist predators because we wouldn't want to knock around ecosystems. To some extent, we are self-policing. I think CRIs have public good instincts, and might behave differently from a private company. Strong financial drivers may overtake environmental impacts."

Stephen Goldson, AgResearch

"We would not put something forward to you unless you were going to approve it. If there is going to be a human health risk or anything, we drop it. So in a way, what ERMA is doing is endorsing what we have already decided. I think it is important that there is some neutral body that makes those decisions. You could have people who maybe were less dedicated, that had different agendas. What happens if you don't have a good way of making decisions about these things?"

Lynley Hayes, Landcare Research

Safety of decisions

The decisions made under the HSNO Act regime are safer for the New Zealand environment than the decisions made in the early days of biocontrol in New Zealand. This is because the environment is considered in the decision-making process under the HSNO Act regime while it was not under previous regimes.

However, it must be noted that in the years leading up to the introduction of the HSNO Act, best practice was being incorporated into the decisions made under the Plants Act. That is, researchers were looking for potential non-target effects on native species as well as crops and beneficial insects such as bees, even though they were not explicitly required to do so in the legislation.

Paynter et al (2004) carried out a survey for impacts on non-target plants to determine if laboratory based host-range testing was reliable for 20 biocontrol agents released in New Zealand. The survey found that overall reliability of host-range testing for biocontrol programmes for New Zealand has been high. Therefore, it is likely that those decisions made in the 1990s incorporated similar considerations as decisions made today, and were comparably 'safe' for the environment.

To date, there are no reported instances of biological control agents introduced to New Zealand resulting in the extinction of a non-target species, although negative impacts on a local population of a non-target species may have occurred. This suggests that there is no observable difference in the safety of decisions made under the HSNO Act regime compared to those made prior to this legislation coming into force.

"Are we safer? Probably not – not particularly. Better-documented, more transparent, better considered, yes, but the decisions are probably the same. HSNO is no guarantee against mistakes."

Richard Hill, Richard Hill & Associates

"From a science perspective I don't think that ERMA has actually made any difference to the quality of the biocontrol introductions."

John Charles, Plant and Food Research

Balancing risk and benefit

There are proponents for a variety of changes to the HSNO Act from removing it altogether to making it more risk averse to prevent all new organism introductions.

Remove regulation

Some people consider that New Zealand does not benefit from having the HSNO Act for the regulation of biocontrol agents. They consider that the previous system, under the Plants Act, was adequate for the regulation of organisms including biocontrol agents, and that the current system is far beyond what is necessary.

Reduce regulation

There are also suggestions that 'the HSNO Act bar' should be lowered, to make it easier to introduce biocontrol agents that will benefit industry or the environment. For example, if a high degree of scientific and technical uncertainty was acceptable, it is possible that the cost of gathering the information to support an application would decrease. In theory, this would make biocontrol a more feasible option for small industries. However, good science and best practice still require that an equal or similar level of testing and information be gathered, suggesting that cost reductions would be minimal.

Increase regulation

Others consider that the HSNO Act regime is not sufficiently restrictive with regard to biocontrol agents. They consider that the use of exotic biocontrol agents should be closely controlled and only allowed in exceptional circumstances in limited environments when the pest problem and the control are scientifically proven. Reflecting a belief that a large part of New Zealand's environmental value exists because of its biological isolation, and compromising that isolation by introducing exotic species is disrespectful toward nature.

Consequence of change

The introduction of the HSNO Act was, from the researchers' perspective, expected to put an end to research into biocontrol and introduction of new agents for biocontrol in New Zealand. In many cases, this expectation has been unfounded, and in fact, some researchers are now extolling the virtues of the HSNO Act regime to colleagues overseas as being more workable than regulation in other jurisdictions.

Any changes to the HSNO Act regime would alter the current balance between risk and benefits, and could potentially come at a cost to New Zealand. Lowering the bar for introductions could result in the introduction of a biocontrol agent that resulted in harm to the environment. Elevating the bar for introductions could prevent the introduction of a biocontrol agent that could have helped protect or enhance the environment.

"It has to be said that my dire predictions back in 1999 haven't come to being at all. We are actually releasing agents at a faster rate per year than we ever have. Totally contrary to what I was spouting off about in the late 90s, I actually now think that one of the main reasons why we are almost having a bit of a golden age in the release of weed biocontrol agents is because of the HSNO Act, and the existence of ERMA."

Simon Fowler, Landcare Research

Deliberate non-compliance

There is a concern that the high costs of obtaining a HSNO Act approval for a new biological control agent may be driving people under ground, leading to an increase in illegal imports and releases of new organisms. This poses great risks to the environment through the potential for disease to be spread from the organism, where legal introductions have to gain clearance under the Biosecurity Act. There is also potential for damage to ecosystems, and native and valued species if the organism feeds on or attacks other non-target species.

The threat of non-compliance and the potential risks associated with that are not a reason to remove regulation altogether. However, if the regulatory hurdles are perceived as being insurmountable, and there is a mechanism to avoid them, non-compliance is likely to become more common.

There are examples of deliberate illegal introductions of biocontrol agents both prior to the introduction of the HSNO Act regime, and more recently.

"If people are getting away with it, it could become a bigger problem. It is always a danger; if something costs money and they can do it for free it will always be a problem."

Barbara Barratt, AgResearch

"Certainly during tough economic times, growers who are struggling with a particular pest are going to be more likely to feel morally able to take matters into their own hands – particularly if it is against a new incursion that the Biosecurity Act has not prevented."

John Charles, Plant and Food Research

"I just have compassion for those small growers because at the very start they might naively come to a scientist quite optimistic that you might be able to help them, and then when you give them the reality of the NZ science funding situation you can't offer them anything at all. They haven't got any hope of getting a solution because they happen to be living and working in NZ in a small industry. They've got no choices in some cases, if it was your livelihood on the line."

Toni Withers, Scion

"There are precedents. In Australia, the Blackberry Rust was released illegally because there was no decision made quick enough – there were desperate people. There are people desperate enough out there who will avoid the law."

Lynley Hayes, Landcare Research

Rabbit Calicivirus Disease – biological control for rabbits

The introduction of Rabbit Calicivirus Disease (RCD) in 1997 is an example of a deliberate introduction of biocontrol agents prior to the HSNO Act. RCD is an acute and fatal disease of rabbits. MAF considered an application for the introduction of RCD for the control of rabbits in 1996-1997. Following much public debate, the application was declined on 2 July 1997. RCD was identified from dead rabbits near Cromwell on 25 August 1997, and MAF initiated a full-scale response. Within three days, RCD was found well beyond the initial site, spread by farmers. Further efforts to contain it ceased, and no charges were laid in relation to the illegal release.

Macrolophus pygmaeus – biological control for vegetable crop pests

More recently, Great Lake Tomatoes, an Auckland based tomato grower, has plead guilty under the HSNO Act to the illegal importation of the new organism *Macrolophus pygmaeus*. *Macrolophus pygmaeus*, a predatory mirid, is commercially available overseas for use as a biological control agent of insect pests in small vegetable crops. Sentencing is set for 19 April 2010 at Pukekohe.

The cost of the Act to New Zealand

The HSNO Act is potentially limiting the benefit that New Zealand could be gaining from the use of biological control by impeding the introduction of new agents.

In the face of increasing concerns about and regulation of herbicides and pesticides, options for pest control are becoming limited. Biological control is regarded by many as the only way forward for many industries in New Zealand. However, the HSNO Act is playing a role in limiting the extent to which biocontrol has been taken up by industries in New Zealand.

"It is driven by need, if a stakeholder feels that they are going to get the benefit and have the funding to put into it, and then it is going to be done, but it is a long expensive process."

Barbara Barratt, AgResearch

Limiting potential benefits of biocontrol in New Zealand

In view of ever increasing environmental awareness and consumer resistance to perceived dangers of pesticide residue in food, and damage to the environment, there is increasing interest in biological suppression of pest species.

The environment is of huge importance to New Zealand in terms of economy (agriculture and tourism), reputation and culture significance. If the HSNO Act is preventing the protection and enhancement of the environment this would be in conflict with its purpose. Some people consider that the HSNO Act is limiting the potential benefits that could be gained from biocontrol through the cost of making an application (fees and information requirements), and the risk that an application will not be approved.

"I think ERMA and the HSNO Act is seen as a world leader of its type. Personally, I don't object to the essential requirements of the Act which is to say – to me the Act doesn't impose anything additional to what we would already have tried to achieve. It might extend the boundaries a bit, but that could be argued to be a good or bad thing. The Act itself, in terms of what is required, isn't an issue; it is more of what it does in practice in terms of preventing biocontrol being taken up by commercial entities, whether it is slowing down the rate of biocontrol introductions that could be achieved if it wasn't there."

John Charles, Plant and Food Research

"Biological control is absolutely vital for our industries. Particularly with, our customer and consumers having increasing lack of tolerance for any form of chemical as demonstrated by the nil detectable residue approach coupled with increasing pressure on existing chemistry with both national and international reviews of our current compounds. We're really running out of options."

Sonia Whiteman, Horticulture New Zealand

Funding

Through the imposition of an application fee, and requiring a high level of certainty about the potential effects of a new biocontrol agent, the HSNO Act has increased the cost of releasing a biocontrol agent substantially. This means that biocontrol is not financially viable for many industries.

Funding for research is limited, and many funding bodies require the end-user to provide some level of funding themselves. Therefore, if a community group or industry is small and unable to contribute financially towards the research, they are unlikely to gain any funding support from the government. This is particularly a problem for small industries that are facing problems specific to their industry.

Large industry groups are more likely to have a research budget themselves, and the ability to lobby for funding for their area.

Some people have suggested that funding would not be a problem, if the funding pool were increased. However, there is no evidence to suggest that an increased funding pool would result in more funding for research to benefit small industries. Those larger groups, where larger benefits can be expected will still be most likely to receive the funding over projects with a smaller number of end users.

Beyond the research required to identify potential biocontrol agents, and test one or more of those organisms for suitability for release in New Zealand, the community/industry group will face other costs that research funding bodies will not fund. This includes the application fee, the cost of consultation and preparing the application, and any costs relating to hearings. This alone represents a substantial cash outlay for small groups and may represent the entire research budget for a given year.

The costs of research and making an application are substantial, and must be paid out far in advance of any benefit that may be accrued by the end user. When an appropriate biocontrol agent is approved for release in New Zealand, further time is taken establishing the agent and integrating its use into current pest management activities. This adds additional costs to the programme.

The high costs of making an application to ERMA New Zealand has caused some groups to delay applying for the release of an agent in order to make a combined application for multiple agents for a single pest.

"The one thing it has made us do is probably delay releasing agents because we'll try and finish testing say three or four agents and put them on the same application."

Quentin Paynter, Landcare Research

"It can be an opportunity cost not to have it (biocontrol) when there are pesticides being used."

Max Suckling¹, Plant and Food Research

"At the same time that HSNO came in requiring this extra level of work, the Foundation was busy reducing the amount that they would put into biocontrol. That has made life difficult. Typically, the funding for a biocontrol agent will be split between Foundation for Research, Science and Technology (FRST) and the industry that is most involved with it. Because FRST won't pay ERMA fees, all those ERMA fees are paid by the industry. And of course that is up front too, before any benefits are accrued."

John Charles, Plant and Food Research

Challenges for industry

The outcome of a biocontrol research programme cannot be predicted at the beginning of the programme. A large amount of time and funding goes into a programme with no certainty that a successful biocontrol will be available at the conclusion.

Technical challenges range from finding and sourcing a suitable agent in the native range of the pest, difficulty rearing the agent in the laboratory, problems growing New Zealand native plants offshore for field tests, overcoming behavioural changes caused by captivity, and interpreting host-range testing results, to whether or not the agent will successfully establish in New Zealand. These difficulties can cause long delays for biocontrol programmes or prevent programmes from going ahead, and costs can increase rapidly.

¹ Dr Suckling was approached for this project for his expertise in biological control, and not in his capacity as a member of the Environmental Risk Management Authority.

In addition, there is no guarantee that an application to release a new biocontrol agent will be approved. The uncertainty of the outcome has led to some groups/industries choosing not to pursue HSNO Act approval for biocontrol agents that have proven successful in other countries.

The combination of the long term nature of biocontrol, the high costs associated with introducing a new biocontrol agent and the uncertainty of a positive outcome means that biocontrol is not a feasible option for many small industries. They have limited funds, and face a myriad of problems, so need to prioritise their time and money into their immediate issues. As such small industries are unlikely to pursue biocontrol, they chose to invest in other pest control methods and focus on shorter-term problems and solutions. In the long term this approach may prove detrimental to those industries and consequently for New Zealand as a whole.

"The main users of biocontrol in the vegetable industry are the greenhouse growers. Our growers often visit and compare their situation with the Dutch who are quite advanced and sophisticated in their approach to biocontrol agents and they have a approximately 12 agents which my industry would like before we would even consider going out and looking for an as yet unknown agent. We currently have a program investigating a potential psyllid biocontrol agent and industry is pretty nervous about how much it is costing. I have to be realistic, doing all this work does not guarantee a positive outcome and I don't know how long it will take. The uncertainty is very unsettling. However, they do visit their cohorts a lot and see what they've got available to them, and are keen to have access to those agents/tools. We've decided to bite the bullet and just go through the process and see how it turns out for us."

Sonia Whiteman, Horticulture New Zealand

"They are missing out. Particularly the small industries, like the citrus industry that is very small. ERMA fees (\$30-40,000) would be almost their entire research budget. For feijoa growers or macadamia nuts or whatever – there is no money. Essentially the Foundation through its research programme has said "forget about it, there is no money coming in from industry therefore they don't matter". Economically that may be the case, but what price [do we put on] rural development?"

John Charles, Plant and Food Research

"The groups missing out at the moment are the forestry growers of alternative species (other than Pinus radiata). Even though they would like biocontrol, they are not a big enough grower body to be able to have their voice heard above the radiata pine growers and therefore significant enough funding is not provided for that. Even though at multiple levels from the very highest government indicators down, everyone's wanting NZ to have a diversified forest industry, and there are drivers at every level, that is not going down to fund biocontrol of insect pests.

I also think the same problem is existing in horticulture as well. Horticulture is obviously very diverse. When there is one significant pest that comes in that is impacting just one crop, such as avocados, they aren't a big enough grower body to be able to fund the biocontrol on their own. Often a pest has to be over more than one crop before they are able to leverage the funding for the CRI to be able to go ahead with biocontrol. For example, in citrus, if a pest is only attacking one of the citrus species, like mainly lemons, but it's not attacking oranges and mandarins as well, then it's just tough, they have to find another way of managing that pest."

Toni Withers, Scion

"The classic example is the eucalypt industry. They have a huge pest load because we are downstream from Australia, huge potential because there are so many different trees you could plant, but it is a small industry because radiata is dominant."

Lisa Berndt, Scion

Conclusions

The HSNO Act is now widely accepted by the scientific community, and generally considered workable. Industry groups are less accepting of the regulation as they consider it increases their costs and they see the outcomes as being uncertain.

Benefits of HSNO Act regulation of new biocontrol agents

The HSNO Act has enabled the introduction of 17 new biocontrol agents since it came into force in 1998, and it has proven to have benefits for the environment, the public, and researchers.

In addition to evaluating the potential effectiveness of a biocontrol agent, the HSNO Act also requires weighing up of all potential effects on the environment before a new biocontrol agent may be introduced into New Zealand.

The HSNO Act imposes transparency on the decision-making process for the introduction of new biological control agents, including statutory timeframes for decisions to be made within, and decision-making criteria. The HSNO Act also gives the public a statutory right to participate in the decision-making, through the submission and public hearing process.

By establishing the Authority as a Crown entity and restricting Ministerial direction on decision-making, the HSNO Act enables decisions to be made about new biocontrol agents independently of political influence.

The HSNO Act requires robust science to support the introduction of any new biological control agents, ensuring that decisions are made with the best information available at the time of decision-making.

Costs of HSNO Act regulation of new biocontrol agents

Although the HSNO Act has strength, there are also costs associated with the regulation of new biocontrol agents under this legislation, particularly for potential end-users.

The HSNO Act brings regulation of biocontrol agents and genetic modification under the same umbrella, resulting in biocontrol agents being treated with the same degree of caution as genetically modified organisms.

The HSNO Act requires robust science to support the introduction of any new biological control agents and places the burden of information on the applicant.

The HSNO Act does not define an unacceptable level of adverse effect or significant impact, as a result researchers tend to be very cautious about what biocontrol agents they investigate for introduction into New Zealand. This caution, along with the high level of information required, may be limiting the number and types of biocontrol agents that are being considered for use in New Zealand.

The HSNO Act has increased costs for potential end-users of new biological control agents through the introduction of application fees and an application form, requirements for consultation with Māori and the wider public, and the potential requirement for public hearings. As a result, the introduction of biocontrol agents is not a viable pest management strategy for many industries.

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² Dr Suckling was approached for this project for his expertise in biological control, and not in his capacity as a member of the Environmental Risk Management Authority