BIOSECURITY SCIENCE STRATEGY
MAF Biosecurity New Zealand
Strategic Science Team
Pastoral House
25 The Terrace
PO Box 2526
Wellington
Tel: 04-894 0324 Fax: 04-894 0730
www.biosecurity.govt.nz

BIOSECURITY NEW ZEALAND

New Zealand Government

A BIOSECURITY SCIENCE STRATEGY FOR NEW ZEALAND

MAHERE RAUTAKI PUTAIAO WHAKAMARU

October 2007

FURTHER COPIES

You can download this publication from www.biosecurity.govt.nz

You can request hard copies of this publication from:
Strategic Science
MAF Biosecurity New Zealand
PO Box 2526
Wellington
New Zealand

Tel: +64 4 894 0100
Email: biosecurity.science@maf.govt.nz

ACKNOWLEDGEMENTS

Red coral photograph – S Wing. Scientist photograph –

Published by:

MAF Biosecurity New Zealand
Pastoral House
25 The Terrace
PO Box 2526
Wellington

Tel: +64 4 894 0100
Fax: +64 4 894 0731
Web: www.biosecurity.govt.nz

ISBN: 978-0-478-31133-4 (Print)
ISBN: 978-0-478-31134-1 (Online)

DISCLAIMER

MINISTERIAL
FOREWORD

New Zealand has developed some of the strongest biosecurity systems in the world. These systems support our primary production industries, which are the cornerstone of our economic welfare, and help us to protect our unique natural environment.

With the rapid growth in tourism and trade, the number of ways that damaging pests and diseases can enter the country has never been greater. At the same time, economic, environmental, social and cultural considerations demand changes to the way we manage pests and diseases. New Zealand's biosecurity systems must change to meet these challenges. We need to be innovative in our search for new ways to keep pests and diseases out and to manage those that are here.

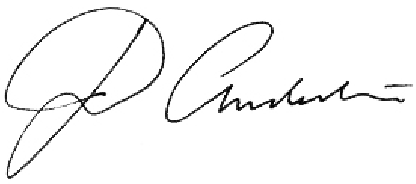
Science across a wide range of disciplines, including mātauranga Māori me ōna tikanga, is an essential key to unlocking the answers to these challenges. Research can identify new ways of protecting New Zealand by managing risks offshore and at the border, and by developing more acceptable and effective ways of managing those pests and diseases that are already here.

There is much to do, but we cannot do everything at once. The science community, lacking clear guidance on what research to undertake, risks overlapping or duplicating research, or using research ineffectively. Existing arrangements are too ad-hoc. The research we undertake needs to be targeted towards identifiable needs for the biosecurity system and implemented to meet those needs.

The Biosecurity Strategy endorsed by the Government in 2003 identified key expectations for biosecurity science. The Biosecurity Strategy called for more effective investment in science and more engagement with the science community in biosecurity decision making. *A Biosecurity Science Strategy for New Zealand – Mahere Rautaki Putaiao Whakamaru* is a major step forward in meeting those expectations.

This document provides priorities and a clear path forward for biosecurity science. It identifies the need for investment in more proactive research across our biosecurity systems. It also outlines a biosecurity science system that will be used to develop clear advice on priority research needs and the uptake of research into the future.

Effective implementation of this strategy will require commitment from all stakeholders and Māori to ensure that New Zealand's biosecurity systems continue to be supported by the best available science.



Hon Jim Anderton
Minister for Biosecurity

EXECUTIVE SUMMARY

A Biosecurity Science Strategy for New Zealand/ Mahere Rautaki Putaiao Whakamaru (the Strategy) addresses the science expectations of the Biosecurity Strategy for New Zealand (2003). It was developed with valuable input from those who use science to improve our biosecurity systems, from science providers and from science funders.

The Strategy highlights the complexity of biosecurity science and the broad range of outcomes that it needs to support. The Strategy recognises that achieving good biosecurity outcomes is dependent on multi-sectoral and multi-disciplinary approaches, and co-operation across the whole science system.

The Strategy identifies a number of challenges for the current biosecurity system. These challenges include the need to:

- prioritise science needs;
- minimise biosecurity risks at the earliest stage possible by increasing our focus on research that is strategic and proactive;
- improve planning, integration and communication in the delivery of science;
- ensure research outputs can be used effectively to improve biosecurity operations and decision making.

As well as identifying current science needs and priorities, the Strategy outlines a fundamental change in the way that biosecurity science is prioritised and directed. It outlines a biosecurity science system that will provide clear advice on priorities to all those involved in biosecurity science. This system will regularly review and identify research priorities as well as advising on implementing research outputs.

VISION AND GOALS

The vision for the Strategy is:

Biosecurity science is effectively contributing to keeping New Zealanders, the plants and animals we value and our unique natural environment, safe and secure from damaging pests and diseases.

To achieve this vision, the Strategy identifies three key areas as needing development. These make up the three high level goals of the Strategy.

These goals, and the objectives and actions that have been identified to help achieve them, are intended to guide all government agencies and biosecurity stakeholders in decision making about biosecurity science.

GOAL 1: SCIENCE DIRECTION. To clearly identify and address research needs.

GOAL 2: SCIENCE DELIVERY. To build and maintain biosecurity science capability and capacity in priority areas.

GOAL 3: SCIENCE UPTAKE. To ensure that uptake of science is timely and effective.

OBJECTIVES AND ACTIONS

The Strategy identifies priority objectives and actions. These priorities will guide strategic planning, resource allocation and investment of research activities for all biosecurity science stakeholders. The Strategy also includes a roll-out plan of all actions over the next 25 years.

The priority objectives and actions for science direction signal the need for a greater emphasis on research with a proactive focus across the biosecurity system. We need to increase our focus on research to support pre-border and border activities. Such research needs to support:

- forecasting for emerging biosecurity risks;
- better understanding of vectors and pathways, and priority pests and diseases;
- managing risk offshore where possible;
- better tools for inspection, detection and treatment;
- more cost-effective surveillance;
- better understanding human behaviour in creating and managing biosecurity risks;
- the development of more effective and efficient eradication, containment and control tools;
- the evaluation of biosecurity impacts on New Zealanders' values.

Science delivery priorities will target resources to the areas of greatest need; build capability and capacity to deliver biosecurity science; and develop and strengthen international relationships.

Priorities for science uptake will ensure efficient access to current biosecurity science information; develop processes to improve communications between science providers and end users; and identify opportunities for improved biosecurity from new technologies.

The Strategy represents a significant step forward in providing priorities and guidance for science to ensure it underpins and transforms New Zealand's biosecurity systems.

CONTENTS

PART ONE
A BIOSECURITY SCIENCE STRATEGY




INTRODUCTION

Biosecurity is the exclusion, eradication or effective management of risks posed by pests and diseases to the economy, environment and human health.[1]

Biosecurity is among the top issues for action in New Zealand. Protecting our biological resources, biodiversity and natural environments, and wellbeing is critical to all of us. Every day we live with exotic pests and diseases in our homes, backyards, crops, livestock and landscapes. Gorse, possums, wasps and wilding pines have invaded our back country. Undaria, didymo, styela and other exotic sea squirts and toxic algal blooms have reminded us that our rivers, lakes, estuaries, coast and the open ocean are not safe from invasion.

Biosecurity threats are a global problem. New Zealand is not alone in having to manage these threats. There are many notable examples overseas of the enormous damage that can be caused by unwanted introductions. The threat is broad, ranging from high-profile pests and diseases such as the red imported fire ant, the North Pacific seastar, foot and mouth disease, and avian influenza, through to relatively unknown but emerging problems.

Winning the war against exotic invaders requires a robust and internationally connected biosecurity system, which aims to protect our economic, environmental, social and cultural values, while enabling international trade and travel to continue.

As well as significant economic interests in biological resources, tangata whenua, as kaitiaki, have a strong cultural connection to taonga species and the ecosystems that support those species. Māori rely on a robust biosecurity system to protect the biodiversity with which they have a whakapapa connection.[2]

New Zealand's biosecurity system is considered one of the most robust in the world. However, biosecurity risks are constantly changing, and we face new challenges on a daily basis as trade and passenger volumes expand along with the number of countries we interact with. We are also experiencing the impacts of a changing environment with new pressures, including climate change, providing additional challenges for biosecurity.

The biosecurity system must be ready to respond to the new suite of pest and disease threats that will result from these changes. It must allow us to protect our natural resources while we continue to engage in the global marketplace and meet our international obligations.

Effectively managing the conflict between our need for trade and travel with our need to protect our natural environments and valued resources will only occur through planned application of innovative research, science and technology. New Zealand, as a relatively small country, has limited resources and therefore our research needs to be strategically planned and directed for maximum benefit to our biosecurity systems.

Tiakina Aotearoa, Protect New Zealand: The Biosecurity Strategy for New Zealand (2003) (The Biosecurity Strategy) emphasised the critical role that science plays in underpinning the biosecurity system, and identified four expectations of science:

[1] Definition from *Tiakina Aotearoa, Protect New Zealand: The Biosecurity Strategy for New Zealand* (2003)
[2] Definitions of these Māori words can be found in the glossary.

- that science is closely involved in the development of biosecurity strategy;
- that the purchase of science is integrated across providers;
- that investment in science be long term to ensure maintenance of key capabilities;
- that the priority for research to improve biosecurity is understood.

The Strategy has been developed to help meet these expectations.

1.1 PURPOSE OF THE STRATEGY

This document looks to the next 25 years and aims to ensure that biosecurity science is directed, delivered and used in a way which maximises the benefit of investments.

It aims to ensure that biosecurity science, which for the purposes of this strategy includes research, science and technology, is contributing to the agreed outcomes for New Zealand's biosecurity system:[3]

- Trade and market access for our products is increased.
- Economic opportunities, growth and prosperity are maintained and enhanced.
- Healthy and rewarding lifestyles, freedom and respect for cultural expression, and enjoyment of the recreational value of the natural environment.
- Our natural and historical heritage, the integrity of ecosystems, and the character of New Zealand landscapes are protected and enhanced.
- Māori biologically based economic and cultural resources are protected, and the relationship of Māori and their culture and traditions, with their ancestral lands, waters, sites, waahi tapu and taonga, is maintained.
- Human health and wellbeing are optimised.

The Strategy readies the biosecurity system for the future by identifying current biosecurity science priorities and providing a model for active and ongoing prioritisation of science needs. It seeks to ensure we have the capability and resources to deliver the required science, and that research results are used effectively to help improve the biosecurity system. The Strategy will be used to guide investment by the Foundation for Research, Science and Technology (FRST) and other research funders.

The Strategy addresses biosecurity research, science and technology needs across the entire biosecurity system. It includes the needs of central and regional government, research providers, Māori, industry, and all other stakeholder groups contributing to the system. It also covers all sectors, terrestrial and aquatic, and environments, primary production and conservation. These different sectors and environments have different needs, due to varying levels of existing knowledge and differing biosecurity threats. Some sector-specific needs are therefore highlighted in the Strategy.

The needs identified in the Strategy also range across the research spectrum from basic targeted research to operational research, and include the translation of science results into everyday management and practical tools.

[3] These outcomes were agreed by Biosecurity Chief Executives Forum in 2004. Organisations represented in this forum are: Ministry of Agriculture and Forestry, Department of Conservation, Ministry of Fisheries, Te Puni Kokiri and Ministry of Health.

1.2 THE SCOPE OF BIOSECURITY SCIENCE

Biosecurity science is the science which underpins the biosecurity system and biosecurity decision making, and develops the knowledge and tools to undertake biosecurity related activities.

The science that contributes to biosecurity is broad and multidisciplinary (see figure 1).

Relevant disciplines include:

- biological sciences including biochemistry, botany, ecology, entomology, zoology, mycology, molecular biology, taxonomy and diagnostics, biometry, bacteriology, virology and immunology;
- medical sciences including both human and veterinary medicine;
- agricultural sciences including agronomy and animal husbandry;
- physical sciences including physics, oceanography, meteorology, geology, engineering and remote sensing;
- social sciences including behavioural psychology and market research;
- computer science and information technology;
- mātauranga Māori.

Biosecurity science is closely linked with other areas of research. Aligning biosecurity research initiatives with strategic research initiatives in other areas is therefore critical. These include strategic initiatives in biodiversity (Department of Conservation (DOC)), sustainable fisheries and aquaculture, (Ministry of Fisheries (MFish)), public health (Ministry of Health (MoH)), food safety (New Zealand Food Safety Authority (NZFSA)), biosafety (Environmental Risk Management Authority (ERMA)), resource management (local government), protection against criminal activity (New Zealand Police and Defence Forces) and mātauranga Māori me ōna tikanga (Māori organisations).

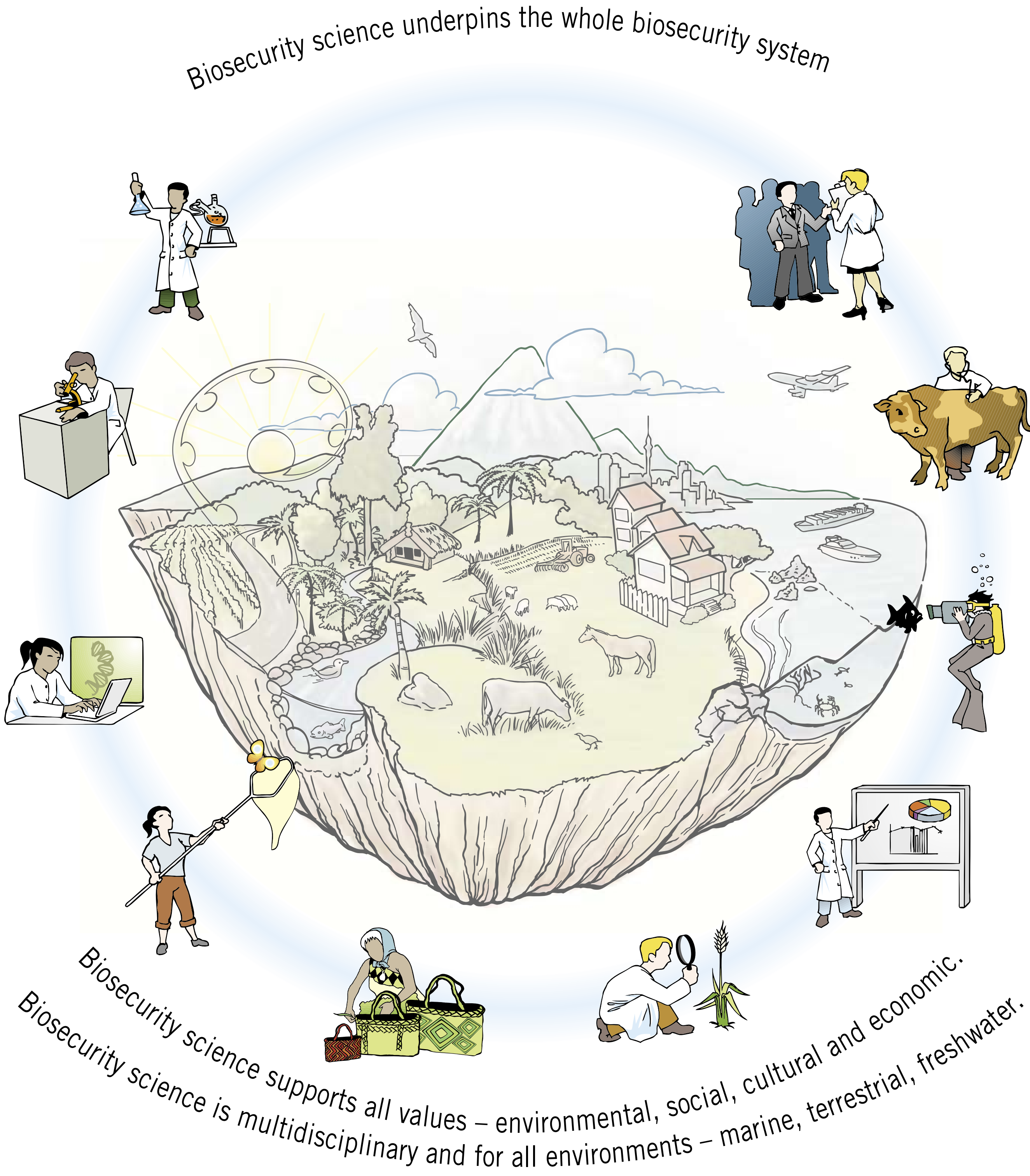
Biosecurity science also contributes to the high standards of animal welfare our society expects, which are governed by animal welfare codes. These high standards are essential to support market access for New Zealand's exports and are also important considerations in pest management and control. The underpinning science for animal welfare is not covered in this Strategy except in relation to animal welfare in pest control and management.

1.3 WHO OWNS THE STRATEGY?

The Strategy was developed by the Ministry of Agriculture and Forestry Biosecurity New Zealand (MAF Biosecurity New Zealand) in partnership with the Ministry of Research, Science and Technology (MoRST).

While the Strategy is endorsed and led by the Government, it is critical for its success that it be owned by all biosecurity stakeholders including research providers and funders, and all those that use biosecurity science. While stakeholders have interests in different areas of biosecurity management, they share a common interest in having science contribute effectively to biosecurity management in New Zealand.

FIGURE 1: THE SCOPE OF BIOSECURITY SCIENCE



The Strategy is based on consultations with biosecurity science stakeholders and a review of previous documents that have considered biosecurity science needs. Input has been sought throughout the development of the document from those who need to be involved in its implementation.

MAF Biosecurity New Zealand and MoRST will have a particular role in monitoring implementation of the Strategy and driving the review process when necessary (see section 8).

1.4 THE STRUCTURE OF THE STRATEGY

Part One of the Strategy provides the context, including the vision and desired outcomes of the Strategy and the challenges to face.

Part Two of the Strategy outlines a system for prioritising science needs into the future and the roles and responsibilities within this biosecurity science system.

Part Three of the Strategy sets out a framework of objectives and actions to achieve the three goals covering science direction, science delivery and science uptake, and provides detail on the implementation and review process for the Strategy.

VISION AND GOALS

2.1 A 25-YEAR VISION

Biosecurity science is effectively contributing to keeping New Zealanders, the plants and animals we value and our unique natural environment, safe and secure from damaging pests and disease.

The Strategy vision weaves together science from all sectors and disciplines, including mātauranga Māori, to support the Biosecurity Strategy vision of "New Zealanders, our unique natural resources, our plants and animals are all kept safe and secure from damaging pests and diseases."[4] The Strategy vision will result in science helping to transform our biosecurity systems, maximising the effectiveness of science for biosecurity – ensuring that science is well targeted and fit for purpose, ranging from highly innovative new solutions through to research that meets short-term operational needs.

To achieve our vision the entire biosecurity system, from pre-border to pest management, and from operations to policy decisions, must be underpinned by science supporting the social, cultural, environmental and economic values important to New Zealanders. Ensuring that science underpins the entire biosecurity system will be dependent upon effective collaboration and co-ordination, which includes Māori concepts and values.

The vision encompasses the protection of those unique natural resources of particular cultural importance to Māori. The Strategy will work to support the contribution of Māori to achieving biosecurity outcomes and strengthen the links between mātauranga Māori and biosecurity science, while respecting the integrity of each knowledge source independently.

2.2 GOALS FOR BIOSECURITY SCIENCE

Achieving the 25-year vision will require effort in three key areas – our goals for biosecurity science.

GOAL 1: SCIENCE DIRECTION. To clearly identify and address research needs, providing clear research direction for biosecurity science, now and into the future, to ensure we have the science we need to best support our biosecurity systems.

GOAL 2: SCIENCE DELIVERY. To build and maintain biosecurity science capability and capacity in priority areas, ensuring we have the capability and the resources for timely and effective delivery of biosecurity science.

GOAL 3: SCIENCE UPTAKE. To ensure that uptake of science is timely and effective, ensuring that science is responsive to biosecurity needs and priorities, and that we are using the science we have to improve biosecurity policy and management and obtain desired outcomes.

[4] *Tiakina Aotearoa, Protect New Zealand: The Biosecurity Strategy for New Zealand* (2003)

CURRENT STATE

Science underpins virtually all aspects of biosecurity, from research into pre-border management, to methods of detecting pests and diseases at the border, to advising on acceptable and effective means of eradicating or managing pests and diseases which reach New Zealand. The current biosecurity system involves a complex network of biosecurity science providers, funders and users.

Inevitable tensions exist between the need for rapid decisions with clear accountability and the need for these to be based on adequate scientific information and evidence. Similarly, tensions can exist between science funders, providers and users due to differing priorities and timelines. However, the goal for all parties is to produce the best possible decision, advice or tool in a timely, resource-conscious manner that delivers maximum benefit for all New Zealanders.

New Zealand biosecurity science has a strong international reputation, particularly in integrated pest management, pest eradication, animal disease control and zoonosis eradication. This country has also successfully applied international developments in biosecurity science and technology, including fruit fly detection and eradication technologies, the use of baggage-scanning X-ray technologies and detector dogs at the border, fumigation technologies, pesticide technologies and molecular diagnostic methods.

Māori have a distinct knowledge base, mātauranga Māori, (knowledge systems, values, concepts, world views that define Māori as a distinct social cultural group) and management approaches (tikanga) that reflect the priorities they have for the protection of taonga species. These are exercised through whānau, hapū and iwi groups and their resource management networks, as well as in co-operation with national and territorial agencies.

Mātauranga Māori me ōna tikanga is an important source of knowledge and information which can add value to New Zealand's biosecurity systems. However, there is currently limited capability with few skilled practitioners in mātauranga Māori me ōna tikanga and limited resources.

3.1 BIOSECURITY SCIENCE PLANNING

While a great deal of biosecurity research is being undertaken, it is usually planned at a sectoral or operational level, for example for the marine environment, or for pest management on conservation land. There is some collaboration between science providers and between providers and industry, but little planning and prioritisation of research at a high level across the biosecurity system.

In general the science community has not been strongly integrated with the biosecurity system except in specific incursion responses, or on high profile issues. Planning and prioritisation is improving with FRST supporting alternative funding arrangements. While these new funding arrangements support closer engagement between science providers and end-users of the science, there is a clear need for greater alignment of research within an overall planning and prioritisation framework to guide funding decisions.

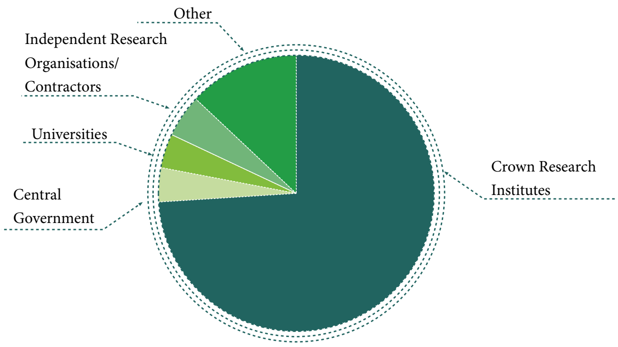
3.2 BIOSECURITY SCIENCE PROVIDERS

Biosecurity science in New Zealand is undertaken by:

- central government agencies with biosecurity responsibilities such as MAF Biosecurity New Zealand, DOC and MoH;

- regional councils;
- Crown Research Institutes (CRIs);
- universities, institutes of technology, polytechnics and museums;
- consultants and other private research organisations;
- some industries, particularly with regard to developing pest management technologies and incursion response tools (see figure 2).

FIGURE 2: PROVIDERS OF BIOSECURITY SCIENCE



Science undertaken by government, industry and contractors or consultants often has an operational or applied[5] focus. University, CRI and private research organisation science ranges from basic[6] to operational research, with CRIs and private research organisations often having a greater focus on targeted basic[7] research.

New Zealand's science community comprises a multidisciplinary range of scientific expertise, knowledge and information, including species collections and databases, relating to biosecurity. However, the capacity in New Zealand is limited in some areas to a small number, or even to just one person. Biosystematics and taxonomy are of particular concern as capacity continues to decline, despite their importance not only to biosecurity, but to other areas of research such as biodiversity.

3.3 FUNDING FOR BIOSECURITY SCIENCE

The current annual investment in biosecurity science in New Zealand is broadly estimated at $37 million. Approximately 60 percent of this funding is provided by central government through the Public Good Science and Technology Fund managed by FRST. Approximately 30 percent is delivered through research funds provided by those agencies with biosecurity responsibilities.[8] Some funding is also provided by regional councils and by industry directly and indirectly through in-kind support, although this is difficult to quantify exactly (see figure 3). Biosecurity science also draws upon and overlaps with science from other areas of research, such as biodiversity, which makes a more precise estimate of biosecurity science funding difficult.

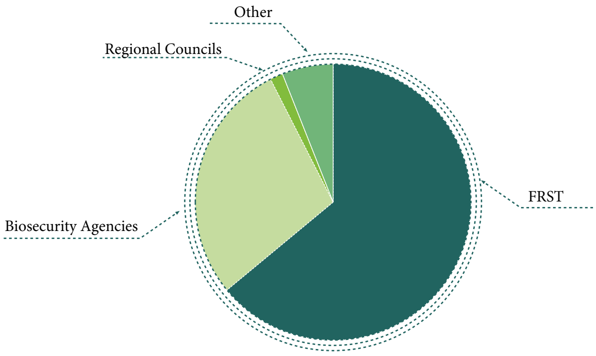
Funding from FRST is generally provided based on the evaluation of proposals sought from the science community in response to broad signals for investment in particular areas. Recently FRST has increasingly engaged "end-users" of science in the development and ongoing oversight of the research programmes that it funds.

Funding from MAF Biosecurity New Zealand and other biosecurity agencies is primarily directed at operational science. This is used to fund projects to meet immediate practical needs such as the development of new treatments and inspection methods for commodities at the border, or new pest eradication and control methods. The funding pool

[5] FRST definition: Research undertaken to acquire new knowledge and directed primarily towards a specific practical aim or objective.
[6] FRST definition: Experimental or theoretical work undertaken mainly to acquire new knowledge of the underlying foundations of phenomena and observable facts without any particular application or use in view.
[7] FRST definition: Basic research undertaken with the expectation that it will produce a broad-base platform of knowledge likely to form the backbone to the solution of recognised or expected current or future problems or possibilities.
[8] Such as MAF Biosecurity New Zealand and the Department of Conservation.

has been essentially static for some years which, in real terms, equates to a decline in funding. Operational funding from different sources is not currently co-ordinated. Industry funding is also largely operational.

FIGURE 3: BIOSECURITY RESEARCH FUNDERS



3.4 PAST TO PRESENT: THE CHANGING FOCUS OF BIOSECURITY SCIENCE

A 2001 review [9] found that 88 percent of biosecurity science expenditure was invested in post-border research (both proactive and reactive research), 5 percent in border research, 4 percent in general research, and only three percent in pre-border research. The review also found that funding for terrestrial biosecurity research (approximately 80 percent) far outweighed funding for freshwater (5 percent) and marine (2 percent) biosecurity science.

Since 2001 there has been an increase in science focused on marine and health-related biosecurity, although science focused on the freshwater environment has decreased. There has also been an increase in science focused on pre-border and border issues since 2001. According to FRST, in 2007 identifiable funding for pest management research represented approximately 55 percent of FRST-funded research, with all other biosecurity related research – pre-border, border, surveillance and incursion response – representing 45 percent.

For terrestrial ecosystems, biosecurity research has focused on the management of pests and diseases established in New Zealand, particularly those affecting agriculture and horticulture. Much less funding has supported research into environmental pests and diseases (acknowledging that some production pests and diseases are also environmental pests and diseases), the exception being funding for specific vertebrate pests such as possums, and for weeds in conservation lands. The proportion of research directed to preventing the establishment of new pests and diseases has increased in recent years, following on from substantial funding being directed to research on new moth pests detected in Auckland in 2003.

Marine biosecurity research received little attention until the 1990s when toxic dinoflagellates (algae) being eaten by shellfish emerged as a significant economic and public health threat. Since then, investment in marine biosecurity science has focused on increasing our understanding of pests already present in New Zealand, improving survey and surveillance methods, developing detection and response tools, genetic work to understand the origins of incursions, and risk analysis. Freshwater biosecurity science has similarly received little attention, primarily focused on pest fish and more recently on responding to the incursion of the freshwater algae didymo.

The Biosecurity Strategy (2003) recognises that human health considerations are a core part of the biosecurity system. Biosecurity science focusing on plant and animal pests and diseases that have

[9] Green, W. 2001. *Review of Current Biosecurity Research in New Zealand*. Prepared for the Biosecurity Strategy Development Team.

impacts on human health had, like marine biosecurity, received relatively little attention until the 1990s. Detections of snakes in containers, of mosquitoes in imported used car tyres and, more recently, the global emergence of H5N1 avian influenza have all resulted in an increase in biosecurity science relating to human health.

To date, social science to support biosecurity has been limited and focused on primary research into values, attitudes and behaviour, rather than on more detailed secondary analyses of this data.

The historic imbalance of biosecurity research – post-border versus pre-border, terrestrial versus aquatic, and economic versus environmental, social or cultural – is changing. As we move into the future it will be important to ensure that the research is balanced to meet the needs of the biosecurity system.

3.5 CHALLENGES FOR BIOSECURITY SCIENCE

The current state of biosecurity science holds a number of challenges, which relate directly to the three goals outlined in section 1, and can be summarised as follows.

We need to:

- clearly identify immediate and longer-term research priorities to support the whole biosecurity system, and minimise biosecurity risks at the earliest stage possible by increasing our focus on proactive research;
- ensure that we have the capability that we require across the biosecurity system; with improved integration, co-ordination and collaboration across all relevant disciplines;
- ensure appropriate science input into biosecurity operations, policy and decision making; with improved planning and processes for uptake of science.

The biosecurity system has been through a process of substantial reform. Biosecurity roles and responsibilities are now better defined, and MAF Biosecurity New Zealand has been established as the lead agency to provide essential system-wide co-ordination and guidance. Similarly, the science funding system is undergoing significant changes with the introduction of a negotiated investment programme and long-term non-contested funding of core science capabilities, including the maintenance of collections and databases. These changes will help us to meet the challenges ahead.

FUTURE STATE

4.1 DESIRED OUTCOMES FOR BIOSECURITY SCIENCE

There is a clear need for improvements to be made to the biosecurity science system to address the challenges and meet the vision and goals outlined in previous sections. The biosecurity science system needs to achieve the following outcomes.

SCIENCE DIRECTION

- Research priorities are clear and updated in a transparent and robust manner in response to evolving circumstances.
- Science tools are contributing to managing biosecurity risks offshore.
- Science is used to achieve targeted intelligence-based interventions due to a better understanding of "risk goods"[10] and the impact of future events and trends.
- There are efficient, effective and humane tools available for biosecurity risk management with new and innovative approaches for better management of existing and potential pests and diseases.
- Better understanding of human behaviour with regard to biosecurity is leading to better targeted biosecurity measures and greater community involvement.
- Science is addressing the full range of values impacted by biosecurity risks.
- Science is contributing to resolving the conflict between protecting our environment and allowing New Zealand to benefit from trade and tourism, and improving the credibility and robustness of New Zealand's pest- and disease-free status.

SCIENCE DELIVERY

- Research providers are receiving clear signals about where to invest in future capability (i.e. skill areas) and capacity (numbers of trained staff and related systems).
- New Zealand has strong capability to respond to existing and emerging pests and diseases of the most concern, including zoonoses.
- New Zealand is developing capability through linking biosecurity science with education and producing high-quality graduates.
- New Zealand researchers have effective domestic and international linkages enabling the right skills and knowledge to be sourced and shared.
- Mātauranga Māori me ōna tikanga is making a significant contribution to biosecurity science and the achievement of biosecurity outcomes.
- The funding system is sufficiently flexible to meet both short- and long-term research needs.
- Research programmes are complementary, co-ordinated and integrated where appropriate to ensure maximum value and minimal duplication.

SCIENCE UPTAKE

- Biosecurity decision making and policy are effectively informed by science.
- Research outputs are meeting the priority needs of biosecurity agencies, industry, and other end-users and can be readily implemented.
- Close engagement between research users and providers is ensuring timely and effective uptake of research outputs.
- Mechanisms are in place to support commercialisation of research outputs where appropriate.
- Māori are engaged and using relevant science to support their role as kaitiaki.
- Collections and databases are maintained, accessible, integrated and up to date.

[10] Defined in the Biosecurity Act 1993 as "any organism, organic material, or other thing or substance, that (by reason of its nature, origin or other relevant factors) it is reasonable to suspect constitutes, harbours, or contains an organism that may –(a) Cause any unwanted harm to natural and physical resources or human health in New Zealand; or (b) Interfere with the diagnosis, management or treatment in New Zealand, of pests or unwanted organisms."

4.2 FUTURE BALANCE FOR BIOSECURITY SCIENCE INVESTMENT

Getting the most effective science to underpin our biosecurity systems relies on prioritisation and getting the balance of investment right. We need to balance research that:

- is proactive and research that is reactive;
- supports the different points at which we intervene in the biosecurity system – for prediction and prevention, border measures, surveillance, and post-border management;
- supports different environments: terrestrial, marine and freshwater;
- supports different values; economic, environmental, social, cultural and human health;
- supports short-term operational needs and longer-term strategic research.

All of these are critical for science to effectively support the biosecurity system, and the balance of investment in these different areas needs to be responsive to the changing needs of the biosecurity system. The current balance of investment in several areas is not meeting the needs of the biosecurity system and requires some adjustment.

RESEARCH FOR DIFFERENT TYPES OF INTERVENTIONS – PROACTIVE AND REACTIVE RESEARCH

Biosecurity science investment has been skewed towards post-border research, with particular emphasis on reactive research to respond to pests and diseases already in New Zealand. But prevention is better than cure. Both pre- and post-border, this balance needs to shift towards more proactive research that will enable us to better predict risks and prevent pests and diseases from arriving; have contingencies in place for dealing with new pests and diseases; ensure early detection, and develop innovative proactive approaches to control and management. In 2001 reactive research far outweighed proactive research. In 2007 this situation has shifted slightly but by 2017 we should aim for the balance to have shifted so that investment in proactive research exceeds that in reactive.

RESEARCH ON DIFFERENT ENVIRONMENTS

To date most of our investment in biosecurity science has focused on terrestrial biosecurity. Our relative understanding and capacity for biosecurity in terrestrial systems is therefore much more advanced than for the aquatic environments. The balance of research investment needs to meet emerging needs in our aquatic environments, while protecting our capacity for biosecurity science in terrestrial environments.

RESEARCH THAT SUPPORTS ECONOMIC, ENVIRONMENTAL, SOCIAL OR CULTURAL OUTCOMES

Biosecurity science in New Zealand has traditionally had a strong focus on biosecurity for economic outcomes, in particular for our primary production systems (except in aquatic environments). While it remains critical to ensure research continues in this area, increased investment is now required to support human health, environmental, social and cultural outcomes.

OPERATIONAL AND LONGER-TERM STRATEGIC RESEARCH

Both operational and longer-term strategic research are critical and we need to ensure that the balance of investment is optimised.

The biosecurity science system described in Part Two will be used to help achieve the optimal balance.

PART TWO
MANAGEMENT STRUCTURE AND MECHANISMS

A BIOSECURITY SCIENCE SYSTEM

This part of the Strategy describes a biosecurity science system that will enable us to move towards the Strategy goals. This system will bring together appropriate expertise and put in processes that will:

- support the capture of biosecurity research needs and opportunities identified from all sectors, stakeholders and Māori;
- use a robust and transparent process to prioritise research issues and needs;
- foster strong researcher/end-user partnerships through improved communication;
- identify relevant research outputs from New Zealand, from overseas, and from outside of biosecurity science;
- effectively feed research outputs into biosecurity management and policy-making decisions.

Details of the biosecurity science system are provided below and described in figure 4.

5.1 MANAGEMENT AND ADVISORY GROUPS FOR BIOSECURITY SCIENCE

A number of groups with different roles will be used to support the biosecurity science system. Three sectoral advisory groups will be established – aquatic, animal and plants focused – made up of expertise from the research community, central government agencies with biosecurity roles, regional government, Māori, industry, and other stakeholders. These groups will review and prioritise biosecurity needs and issues requiring research within their sector. The groups will also maintain oversight of research outputs.

The priorities developed by the sectoral groups will be provided as recommendations to a cross-sectoral science advisory group which will draw on a similar range of expertise. It will provide technical and scientific advice on research priorities and implementation of research across the whole biosecurity system.

Recommendations from the cross-sectoral group will be provided for endorsement to a high level science advisory committee, drawn primarily from biosecurity agencies. This committee will have a pivotal role, both in signalling agreed research priorities to science funders and providers, and in driving the integration of science outputs with biosecurity agency activities.

Existing forums will be used, where possible, for the advisory groups. It is anticipated that the high level science advisory committee will be approved by the Minister for Biosecurity, and the other advisory groups by the Director General of the Ministry of Agriculture and Biosecurity.

5.2 SCIENCE DIRECTION IN THE BIOSECURITY SCIENCE SYSTEM

RESEARCH NEEDS ARE PRIORITISED AND PRIORITIES COMMUNICATED TO FUNDING AGENCIES

Direction for research needs will be initiated by a wide and inclusive process to identify critical issues, questions, research needs and opportunities. This process will require active participation across biosecurity agencies, science providers, regional councils, industry groups, Māori and stakeholders. Participation will be provided for through new mechanisms such as web-based tools and through existing groups and forums where possible.

Collated research needs will be provided to each of the sectoral science advisory groups, who will identify and recommend priorities at a sectoral level. A transparent process to be developed based on the Biosecurity Decisions Framework will be used (see Appendix B). Sectoral priorities will be provided to

the cross-sectoral science advisory group. This group, which is likely to have cross-membership with the sectoral groups, will use the same prioritisation process to formulate advice to the high level committee on priorities for the whole system. The high level committee will review and sign off on agreed priorities.

5.3 SCIENCE DELIVERY IN THE BIOSECURITY SCIENCE SYSTEM

RESEARCH IS FUNDED AND UNDERTAKEN

Agreed biosecurity research priorities will be communicated to relevant funding bodies including FRST, MAF Biosecurity New Zealand, DOC, regional councils and industry groups. These priorities will guide investment in biosecurity research, which will occur through the existing funding processes of these organisations.

As currently occurs, after funding decisions have been made, a range of providers will undertake biosecurity research in priority areas. It will be important that providers and end-users communicate throughout the research to ensure it is fit for purpose and aligned with strategic objectives.

5.4 SCIENCE UPTAKE IN THE BIOSECURITY SCIENCE SYSTEM

RESEARCH OUTPUTS ARE COLLATED AND IMPLEMENTED

This part of the system involves the same groups as those mentioned under "science direction" (above). Research outputs from within the system and relevant research results from other disciplines or from overseas will be collated. These research outputs will be communicated to biosecurity agencies and other end-users as well as being provided to the advisory groups. Ideally the biosecurity agencies and groups will already be well informed and closely engaged in the research through regular communication with science providers.

The advisory groups and high level committee will oversee research results and their uptake and implementation. This oversight will include identifying emerging research needs or implementation issues, and prioritising the implementation of research where significant new resources are required (using a similar prioritisation process to that for science direction).

The advisory groups and management committee will also provide advice on the broader implications of the body of research that has been undertaken. This advice will be communicated to biosecurity agencies and groups as appropriate or fed back into the research direction process. Oversight of uptake will also provide opportunities to monitor the overall performance of the system.

As the research outputs are used to improve our biosecurity systems, the process will have come full circle.

5.5 BIOSECURITY SCIENCE IN AN EMERGENCY RESPONSE

In the event of a biosecurity emergency, such as a new incursion, there is a need for fast decisions. In an emergency the above process would be replaced by direct interactions between the responsible biosecurity agency, usually MAF Biosecurity New Zealand, and the research providers, with engagement of the advisory groups if necessary.

5.6 ROLES AND RESPONSIBILITIES IN THE BIOSECURITY SCIENCE SYSTEM

For a biosecurity science system to function, a large number of entities with different but complementary

roles will need to work together effectively. Their proposed roles and responsibilities are outlined in this section. Each group will have a responsibility to identify science needs and issues for their area and appropriate ways of delivering and ensuring uptake of this science. This collective input will improve the biosecurity system.

CENTRAL GOVERNMENT

Within the biosecurity area, MAF Biosecurity New Zealand will continue to be the lead agency with a role in science co-ordination and oversight. MAF Biosecurity New Zealand's Strategic Science Team will play an active role in supporting and facilitating the biosecurity science system, including collating research needs and issues, co-ordinating and contributing to the sectoral advisory groups, collating research outputs, and co-ordinating reporting and review.

All central government agencies with biosecurity responsibilities will each play a role in identifying biosecurity science requirements and funding operational research programmes. These agencies will participate in the work of the advisory and high level science advisory groups in the new biosecurity science system.

FRST will continue to be a key funding body, awarding most central government funding for biosecurity science, ranging from basic targeted science to applied research.

LOCAL GOVERNMENT

Local government will have an important role in identifying and clearly signalling regional research needs and ensuring appropriate delivery and uptake of science within the region. It will also have expert input to advisory groups and be represented on the high level science advisory committee.

INDUSTRY

Industry bodies or representatives will feed sectoral research needs into the system. They will also provide expert input into the advisory groups, as indicated in figure 4, and transfer science outputs and information to their members to facilitate science uptake.

SCIENCE PROVIDERS

Science providers will identify research needs and issues, provide expert input to the advisory groups, identify opportunities for innovation, and continue to undertake their research in consultation with end-users.

MĀORI

Māori are best placed to identify biosecurity issues and research needs important to Māori. Māori also have a particular responsibility for ensuring appropriate delivery and integration of mātauranga Māori me ōna tikanga into biosecurity science. Integration must occur in a way that maintains the cultural integrity of these knowledge systems and cultural practices.

Māori also have a role in the uptake of science, including uptake of mātauranga Māori me ōna tikanga. Māori networks can be used to promote uptake of science with the goal of improved biosecurity.

OTHER STAKEHOLDERS

Other stakeholders, including the general public, will have a role in identifying biosecurity research needs and issues and in supporting the uptake of relevant research.

5.7 PRINCIPLES FOR RESOURCING BIOSECURITY SCIENCE

The Biosecurity Strategy called for the development of a framework for funding biosecurity-related activities. In 2005 the Government endorsed The Biosecurity Funding Review, which prescribed that any parties required to pay for biosecurity-related activities should be able to do at least one of the following:

- change their behaviour to reduce the cost of the service or the risks that give rise to the need for it over time;
- assess whether the true benefits of the service at its current levels outweigh its costs on an ongoing basis, and thereby influence its ongoing provision;
- influence whether the service at its current levels is being provided in the most cost-effective manner.

Where those parties are unable to do any of the above, it is likely that Crown funding will be appropriate.

It would be consistent to apply the same principles to the funding of biosecurity science.

As the Crown funds research of a "public-good" nature – where the benefits are so diffuse that they do not accrue to discernible individuals or groups – it is logical that the Crown will be the major research funder. However, other stakeholders will also have roles to play.

For example, in some cases regional councils will have an interest in funding research of a "local" public-good nature, where the benefits accrue to a local or regional population. Industry, in the form of industry bodies or individual companies, may have a role in partnership with government in supporting research from which they will directly benefit.

Table 1 provides a guide for resourcing roles in biosecurity science, although ultimately the decision to support a biosecurity science initiative rests with the particular group.

5.8 ACTIONS REQUIRED TO DEVELOP THE BIOSECURITY SCIENCE SYSTEM

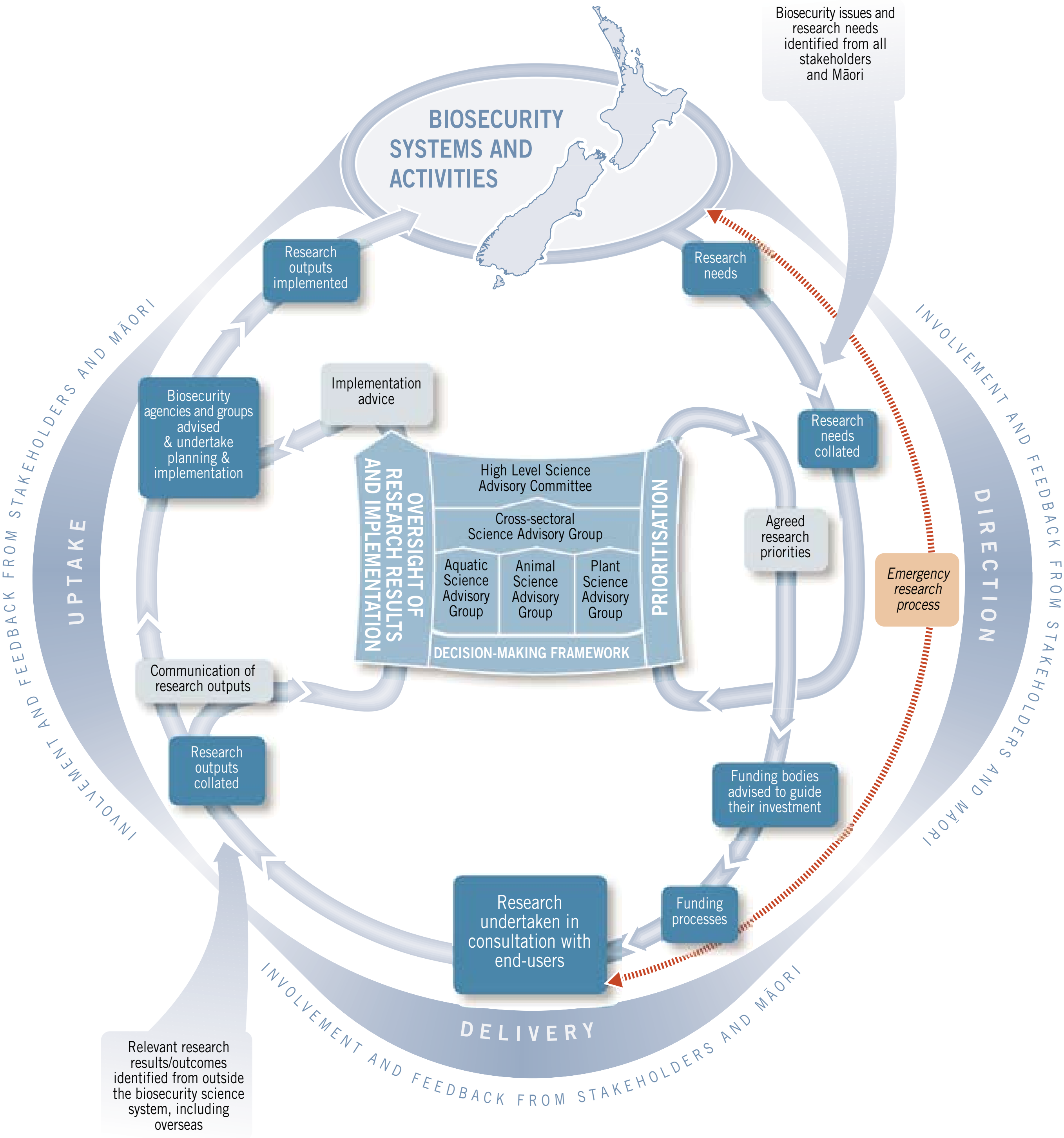
A range of actions will be required to develop the biosecurity science system described in this part of the Strategy, including:

a. Establish the forums for the biosecurity science system (high level science advisory committee, cross-sectoral science advisory group, and sectoral advisory groups) and develop their terms of reference.
b. Develop the procedures to be used by the forums for prioritisation of research needs and research uptake using the Biosecurity Decisions Framework.
c. Establish mechanisms for capturing and collating biosecurity research needs and issues from all stakeholders and Māori, including needs and issues identified through biosecurity activities, using existing networks and forums where possible.
d. Establish mechanisms for capturing and collating biosecurity research outputs, including from international sources.
e. Develop processes to align current research programmes with the priorities identified in the Strategy and through the biosecurity science system.

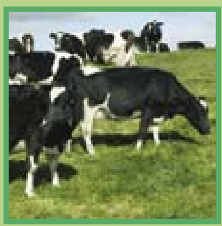
TABLE 1 RESOURCING FOR BIOSECURITY SCIENCE

ORGANISATION	TYPES OF RESEARCH
Foundation for Research, Science and Technology	Basic targeted and longer-term research into future risks and opportunities; new pre-border and border risk management and alternatives; new diagnostic, surveillance and incursion response/pest management tools; and ecosystem impacts/modelling.
Ministry of Agriculture and Forestry Biosecurity New Zealand	Immediate to medium-term research (in-kind as well as direct financial contributions) into pre-border and border risk management methods and alternatives; initial investigations, surveillance, and diagnostics; national pest management assessments; and tools for specific responses/strategies.
Department of Conservation	Immediate to longer-term research (in-kind as well as direct financial contributions) into biosecurity contingency plans of relevance to the conservation estate or indigenous flora and fauna; specific incursion response and pest management initiatives; and broader ecosystem research.
Regional councils	Immediate and medium-term research (in-kind as well as direct financial contributions) into biosecurity contingency plans of relevance to regions; specific incursion response; and regional pest management initiatives.
Importing industries	In partnership with government, immediate and medium-term research into pre-border and border risk-management methods and alternatives.
Primary production industries	In partnership with government, immediate and medium-term research into surveillance, preparedness, and incursion response programmes; and pest and disease management activities that have a direct impact on their production and that facilitate compliance with importing countries' requirements.
Ministry of Health/Health Research Council	Does not directly fund areas identified as biosecurity but the investment portfolio on communicable disease includes related research in exotic and emerging diseases of humans, including development and evaluation of surveillance approaches.

FIGURE 4: THE BIOSECURITY SCIENCE SYSTEM



PART THREE
BIOSECURITY SCIENCE NEEDS AND PRIORITIES


OBJECTIVES AND ACTIONS

This part of the Strategy identifies the objectives for biosecurity science across all three goals and sets out actions to achieve the objectives. The list of actions is not intended to be exhaustive or restrictive, but to provide a strong signal on current needs and priorities.

All the objectives and actions identified are important for the success of the Strategy and the effectiveness of biosecurity science. However, not all work can be undertaken at once and so the objectives and actions have been prioritised. These priority objectives and actions are provided in section 10.

A "roll-out" plan for the next 25 years, suggesting when particular emphasis on each action may be most appropriate, is included in Appendix A.

The objectives and actions will be refined and re-prioritised over time, through the biosecurity science system.

6.1 GOAL 1: SCIENCE DIRECTION. TO CLEARLY IDENTIFY AND ADDRESS RESEARCH NEEDS

The research required to achieve our desired biosecurity outcomes must support the complete biosecurity system from pre-border prevention science, to management of border risks, through to pest and disease management. This section outlines current research needs across the system. These provide a starting point – future needs will be identified and prioritised using the system described in Part Two.

OBJECTIVE 1.1: FORECAST EMERGING BIOSECURITY RISKS AND DEVELOP CONTINGENCY PLANS

The world we live in is not static. Biosecurity risks can change dramatically due to a large range of global influences as well as changes within New Zealand. We need to improve our ability to forecast, assess and respond to emerging biosecurity risks to New Zealand, so that we can target research and develop contingency plans and measures to address the risks before it is too late.

KEY ACTIONS TO MEET OBJECTIVE 1.1 ARE:

a. Identify emerging pests and diseases both nationally and internationally, and analyse the potential associated biosecurity risks and measures to manage these.
b. Develop methods to better monitor and analyse trade patterns and the changing risk status of trading partners, and identify potential changes in the suite of pests, diseases and vectors that pose a risk to New Zealand.
c. Analyse the potential biosecurity risks from increasing tourist numbers, changes in countries of origin of tourists, and changes in location and types of tourism activities.
d. Develop methods to better monitor and analyse potential changes in biosecurity risks resulting from climate change.
e. Analyse potential biosecurity risks and opportunities resulting from shifts in resource use and availability, such as energy or food resources, and from changes in transport technologies (domestically and internationally).
f. Analyse the potential biosecurity risks and opportunities for risk management from changes in industry practices, such as the intensification of production systems.
g. Assess the biosecurity implications of increased urbanisation and lifestyle changes of New Zealanders.

OBJECTIVE 1.2: UNDERSTAND THE CHARACTERISTICS OF HIGH-PRIORITY PESTS AND DISEASES

Achieving a better understanding of the risks we face from pests and diseases, including their current and potential impacts, will improve our ability to keep them out and justify the measures required to do so. It will also improve our ability to appropriately manage those pests and diseases which are already established. Effort in this area will need to be carefully focused and prioritised, as it is not feasible to fully understand all known pests and diseases.

We need to compile risk profiles of priority pests and diseases that threaten New Zealand where they are yet to be characterised. These profiles need to include details on hosts, potential and current range, potential impacts, risk of establishment, identification and border detection, surveillance and eradication or control methods, and the most effective point of intervention. While in some cases this information has been compiled internationally, it is not always relevant in the New Zealand context. Furthermore, there are gaps, particularly in relation to emerging pests and diseases and those in marine and freshwater environments. Relevant risk profiles will improve our ability to target resources at the higher-risk pests and diseases, and to better understand their relative risk.

The complex interactions of pests and diseases with their hosts and environments, and the fact that organisms may be present at low densities for a long time before they are identified as a risk (that is the populations have long lag times), means that the effects of a new pest or disease on an ecosystem can be difficult to predict.

KEY ACTIONS TO MEET OBJECTIVE 1.2 ARE:

a. Increase understanding of the biology, ecology and impacts of categories of pests and diseases, their relative biosecurity risks and the most effective points of intervention.
b. Increase understanding of the epidemiology of zoonoses (diseases capable of infecting both humans and animals).
c. Increase understanding of multi-species pest dynamics (population level interactions).
d. Increase understanding of the mechanisms of virulence change.
e. Increase understanding of lag times and the naturalisation process.
f. Increase understanding of "invasiveness" and why some exotic flora and fauna establish and/or spread and others do not.
g. Develop and test potential vaccines for potentially significant diseases for use on zoo animals and rare or endangered indigenous species.

OBJECTIVE 1.3: ANALYSE RISK PATHWAYS AND VECTORS FOR ENTRY AND DISPERSAL OF PRIORITY PESTS AND DISEASES

Better assessment of the risks associated with different pest and disease vectors and pathways will make management measures more effective and efficient. An increased understanding of external and internal pathways will complement knowledge gained from the previous two objectives, i.e. knowledge of emerging biosecurity risks, and pest and disease characteristics.

New research is required to evaluate relative risks from various pathways into New Zealand. We need to better understand the magnitude of risk associated with different pathways and how the frequency with which a pest or disease enters New Zealand (also known as propagule pressure) influences the probability of its establishment and invasion, compared with other environmental factors. Examples of poorly understood vectors include soil, ornamental plants, wooden furniture, and aquarium species. In the marine environment, diseases pathogens and parasites may also be present in the species that arrive as biofouling or in ballast water, and the magnitude of these risks is unknown.

Internal pathways and vectors are also of concern. We need a better understanding of the routes and mechanisms by which damaging pests and diseases can disperse within New Zealand, and how this relates to their epidemiology. This research, combined with a more detailed knowledge of natural dispersal and the effectiveness of our existing natural barriers, is critical for designing internal quarantine measures.

Tools and methods to trace incursions back to pathways to learn from experience, and forward to better understand how pests and diseases spread, will be very valuable, for both international and internal borders.

KEY ACTIONS TO MEET OBJECTIVE 1.3 ARE:

a. Increase understanding of the pathways through which high-risk pests and diseases can enter New Zealand, including pest and disease vector/host/commodity relationships, to better characterise risk goods and the magnitude of risk associated with the pathway.
b. Increase understanding and characterisation of the natural and human-mediated pathways through which damaging pests and diseases can spread within New Zealand, and use vector and pathway analysis to identify the most effective points of intervention.
c. Develop methods to trace incursions back to, and forward from, the source.
d. Improve understanding of the factors which affect the probability of establishment, including the frequency of likely entry.
e. Determine the potential for diseases, pathogens, and parasites associated with marine organisms to enter and establish in New Zealand.

OBJECTIVE 1.4: DEVELOP METHODS FOR MANAGING RISKS OFFSHORE

Wherever possible it is highly desirable to undertake biosecurity measures offshore[11] to reduce risk. Offshore treatment places responsibility for risk management back at the source and requires New Zealand to be explicit about its biosecurity requirements. Substantial gains have already resulted from some initiatives in this area, particularly in the importation of fresh produce.

In order to support the strong country-to-country relationships required for successful offshore treatments, New Zealand needs to further develop expertise in this area. We need to design, understand and apply cost-effective and environmentally sound technologies for inspection,

[11] Where "offshore" is defined as being either in the country of origin or in transit prior to arriving within New Zealand's territorial waters.

detection and treatment, to remove risk organisms from trade pathways. We also need to be aware of the need to maintain and develop our own export initiatives, and invest in research to provide biosecurity assurances to our trading partners.

In developing this expertise, New Zealand will contribute substantially to the development of internationally-based initiatives to reduce the world biosecurity impacts of trade and travel. Advancements made in this area will potentially have internal application, such as treatment tools at the border.

KEY ACTION TO MEET OBJECTIVE 1.4 IS:

a. Develop and/or validate both specific and broad-spectrum measures, tools and strategies that are cost-effective, safe and environmentally sound for managing risk offshore, either before departure from the country of origin or while in transit.

OBJECTIVE 1.5: DEVELOP ENHANCED TOOLS FOR INSPECTION AND DETECTION

Risk goods must meet relevant import requirements when entering New Zealand. Border staff need effective inspection and detection tools that can test or audit compliance with these regulations, whilst also allowing increased throughput and reduced labour input over time.

Valuable tools may range from the technologically complex, such as sensors that detect exotic organisms, through to simple chemical indicators. Technologies will need to be cost-effective, safe, environmentally acceptable and reliable. Particular challenges include detection and inspection tools for risks associated with containers, used cars, unitised commodities such as shrink-wrapped pellets, machinery, ballast water, biofouling on vessels, nursery stock, seeds and aquarium trade species. There is also a need to review the statistical validity of sampling and inspection regimes for exports.

Enhanced tools in this area will reduce the risk to New Zealand of pests and diseases slipping through our borders, or of trade being unnecessarily delayed. They will also provide equivalent certainty to other countries in regard to the safety of our exports.

KEY ACTIONS TO MEET OBJECTIVE 1.5 ARE:

a. Develop improved tools for inspection and detection of biosecurity risks at the border, including tools to validate compliance of goods with official requirements.
b. Develop inspection and detection tools to test the compliance of our exports with the biosecurity requirements of our trading partners.
c. Develop alternatives to visual inspection for providing assurance of compliance with standards for both imports and exports.

OBJECTIVE 1.6: DEVELOP METHODS FOR RAPID IDENTIFICATION OF PESTS AND DISEASES

Rapid and accurate identification of pests and diseases, including particular strains, is critical for effective biosecurity risk management and in meeting legislative requirements (i.e. the Hazardous Substances and New Organisms Act). Tools and capability in this area are required for use at the border, in post-border surveillance, and for use in delimiting surveys during incursion response.

Existing tools for rapid identification range from traditional diagnostics through to molecular identification tools such as genetic probes. A range of techniques are currently available but tests can be time-consuming, expensive and unreliable, producing false results. All of these issues

significantly affect the ability to make timely and effective decisions.

Identified challenges for the development of identification tools are to: improve reliability and accuracy; improve understanding of the limitations of different tests; enable large numbers of samples to be processed rapidly; allow for multiple organisms to be checked for in one test; optimise suites of tests to provide certainty in critical areas such as releasing organisms from quarantine; and to develop effective tools for all environments – terrestrial, freshwater and marine. Addressing these challenges will provide efficient and effective identification of pests and diseases across the biosecurity system.

KEY ACTIONS TO MEET OBJECTIVE 1.6 ARE:

a. Develop new and improve existing identification and diagnostic tools for the border, post-entry quarantine and transitional facilities, for imports and exports.
b. Develop new and improve existing identification and diagnostic tools for surveillance and incursion response.
c. Develop new and improve existing tools for the detection of genetically modified organisms.
d. Identify priority biosecurity risk taxa for which taxonomic information is lacking and address gaps in information, including biosystematics research where necessary.

OBJECTIVE 1.7: DEVELOP IMPROVED TREATMENT TECHNOLOGIES

The development of more cost-effective, safe and environmentally acceptable treatments for risk goods arriving at the border will improve the efficacy of our border measures. The fumigant methyl bromide is a key treatment agent, but must be used carefully to address health concerns and is increasingly considered to be environmentally unacceptable.

Treatments need to be safer. Improvement is needed in the way existing treatments are applied and contained. Methods for the safe destruction or recycling of fumigants after use are also required.

Treatments need to be effective against as wide a range of risk organisms as possible. We need to clearly understand their efficacy against different organisms and under different conditions; their impacts on the imported goods that are treated; and their social and cultural acceptability.

Particular challenges for the terrestrial environment include better treatments for plant material, seeds, soil, containers and container contents, and used cars. We also need to develop treatments for the aquatic environment for effectively anti-fouling vessels and safely cleaning them.

Ensuring that our commodities continue to be accepted into other countries is critical for New Zealand, so we need to ensure treatments applied to our exports are also effective and efficient.

KEY ACTIONS TO MEET OBJECTIVE 1.7 ARE:

a. Develop improved treatments for risk goods at the border and in transitional facilities, including clear, scientifically-supported information on target organisms and details required for effective application, such as concentration/temperature/time data.
b. Develop methods to clean and treat vessels to minimise biofouling and ballast risks – treatments should also be effective for any associated diseases and pathogens.
c. Develop alternatives to methyl bromide and improve the use of existing fumigant treatments through better application, and methods for the safe destruction or recycling of fumigants after use.
d. Develop new, and improve existing, post-harvest treatments for export commodities to increase cost-effectiveness and meet increasingly stringent environmental and human safety standards.

OBJECTIVE 1.8: DEVELOP COST-EFFECTIVE SURVEILLANCE TOOLS AND METHODS AND APPLY WITHIN INTEGRATED SURVEILLANCE SYSTEMS

There is an increasing demand on surveillance systems to provide early detection of incursions in New Zealand; for international reporting to demonstrate that our exports are free of pests and diseases; and to help manage pests and diseases. New tools need to support both passive and active surveillance programmes and maximise the chances of accurate detection at minimum cost, whether undertaken by government or industry. Particular areas of need include marine and freshwater environments, where methods and tools are relatively limited. Research should also aim to assess whether new surveillance needs can be met by modifications to existing surveillance programmes.

Methods for evaluating surveillance activities in terms of cost-effectiveness and the sensitivity/probability of detection of different organisms are also needed, to enable better resource allocation. Data collected from surveillance should be interoperable with other data storage and management systems.

KEY ACTIONS TO MEET OBJECTIVE 1.8 ARE:

a. Develop more targeted and cost-effective surveillance and early detection techniques, including remote techniques and techniques designed to detect priority organisms that are difficult to detect at low prevalence.
b. Develop or adapt surveillance tools and techniques for wider use within industry, agencies, and communities, including Māori groups.
c. Develop integrated surveillance systems and the means to capture and interpret surveillance information from multiple sources (e.g. integrating 0800 number reports and veterinary reports with targeted surveillance for an animal disease).
d. Develop robust methods for evaluating surveillance activities in terms of cost-effectiveness, sensitivity and probability of detection.

OBJECTIVE 1.9: DEVELOP CONTROL, ERADICATION AND CONTAINMENT METHODS FOR POTENTIAL AND ESTABLISHED PRIORITY PESTS AND DISEASES

We continue to make substantial investment in managing the impacts of pests and diseases that are already established in New Zealand. To improve this management, we need control tools that are humane, socially and culturally acceptable, and which minimise impacts on non-target species and the environment.

For sustainable pest and disease management we need to recognise when control is justified and cost-effective and when it is not. This recognition must be based on, among other factors, a better understanding of thresholds below which populations need to be maintained to minimise damage.

When an incursion is identified, rapid decisions need to be made regarding the possibility of eradication and/or containment. Tools and techniques developed for containment and eradication must be practical, effective, economically feasible, and integrated with delimiting surveillance tools. There are particular needs for:

- eradication and control tools for the aquatic environment;
- safe and socially acceptable eradication tools for use in urban environments;
- more humane and effective methods for controlling vertebrate pest animal species;
- containment or humane killing of animal disease carriers.

KEY ACTIONS TO MEET OBJECTIVE 1.9 ARE:

a. Develop more cost-effective, socially and culturally acceptable, and humane tools and techniques to control, contain and eradicate pests and diseases, where tools are limited.
b. Develop pest and disease management tools that minimise impacts on other species, particularly on threatened and taonga species.
c. Develop methods to assess feasibility of eradication, containment or control.
d. Develop methods to assess the impacts and effectiveness of pest and disease control programmes.
e. Develop integrated pest management approaches for priority pest groups, defined at an ecosystem/ production system level, to reduce populations to below economic thresholds, and to safeguard environmental and human health.
f. Develop effective, practical and acceptable alternatives to mass slaughter of production animals in response to incursions of serious livestock diseases.
g. Develop methods for the safe disposal or treatment of infected organisms, equipment and facilities during an incursion response.

OBJECTIVE 1.10: DEVELOP A COMPREHENSIVE UNDERSTANDING OF HUMAN VALUES AND BEHAVIOUR IN CREATING AND MANAGING BIOSECURITY RISKS

Understanding how important biosecurity is to New Zealanders in relation to their changing values, lifestyle and demographics will help to ensure that biosecurity management measures are effective, and appropriately targeted and communicated.

Social research can improve our understanding of attitudes towards, and compliance with, biosecurity-related activities. To improve compliance we need to assess the reasons for a particular behaviour or

attitude and use the appropriate incentives and compliance tools to try and change that behaviour.

The application of this research, along with a clear articulation of behaviours required to manage biosecurity risks, could significantly increase the effectiveness of biosecurity measures and assist people in managing and taking responsibility for their own biosecurity-related risks. Other anticipated outcomes are: increased compliance with border requirements; accurate and timely reporting of new and unwanted pests and diseases; and support for post-border incursion response and pest management programmes.

KEY ACTIONS TO MEET OBJECTIVE 1.10 ARE:

a. Increase understanding of social and cultural attitudes towards, and understanding of, biosecurity risks and management measures, including the impact of changing demographics.
b. Identify current behaviours affecting biosecurity risk management for different sectors, the reasons for that behaviour, and the motivators, barriers and drivers relating to desired behaviours.
c. Increase understanding of the effectiveness of compliance tools and methods of modifying behaviours, such as sanctions, and the impact of improving the services provided by regulatory bodies.
d. Increase understanding of behaviours associated with passenger and importer non-compliance with biosecurity requirements.

OBJECTIVE 1.11: ASSESS THE ACTUAL AND POTENTIAL BIOSECURITY RISKS TO ECOSYSTEMS

We need to better understand the level of tolerance of our indigenous ecosystems, flora and fauna to pests and diseases; their capacity to act as hosts or vectors; and the exposure of our threatened species to such threats. This information, along with better understanding of risks to all the values that we are protecting (environmental, economic, social and cultural), will enable us to better target our investment in biosecurity measures.

Human modification has resulted in many changes to New Zealand's indigenous ecosystems. An understanding of how pest and disease impacts interact with other human impacts, such as pollution, habitat modification, nutrient run-off, modified water flows and urbanisation, will help us predict impacts from biological invasions and improve targeting of management measures.

The vulnerability of our marine and freshwater ecosystems are least understood, and baseline studies are needed in unsurveyed high-risk and nationally important areas.

The research required to understand and predict biosecurity impacts on ecosystems will support other outcomes such as biodiversity conservation, kaitiakitanga, natural resource management and community health. Much of this work is long-term but has the potential to fundamentally change how we view and manage biosecurity risks.

KEY ACTIONS TO MEET OBJECTIVE 1.11 ARE:

a. Increase understanding of, and develop methods to assess and predict the susceptibility of indigenous ecosystems and species, particularly those which are threatened, to pests and diseases.
b. Increase understanding of the potential for taxa in New Zealand to act as hosts or vectors for exotic pests and diseases.
c. Develop the ability to predict biosecurity risks to taonga and other culturally significant resources, and to determine the likely significance of the risk to tangata whenua and Māori organisations.
d. Develop methods to assess interactions between different human impacts on ecosystems, and their relative risk, to improve targeting of management measures. (For example, assessing the interactions and relative risks of pests and diseases, pollution and changes in land or water use).
e. Conduct targeted baseline studies of New Zealand's flora and fauna for priority unsurveyed areas or taxa.
f. Develop robust tools to evaluate the impacts of biosecurity threats on economic, environmental, social and cultural values for New Zealand's ecosystems.

OBJECTIVE 1.12: ASSESS APPLICABILITY TO BIOSECURITY OF DIFFERENT APPROACHES TO RISK MANAGEMENT

While the challenges facing the biosecurity system are substantial, they are not necessarily unique. Other sectors face similar challenges in dealing with ever-increasing demands for certainty in light of large information gaps, e.g. in health, transport safety, and justice. As a result there are many people and organisations within New Zealand and internationally that work within the risk-management area. There is also now quite a large body of literature covering risk assessment and management practices. We need to determine the extent to which risk management theories and tools being developed and/or used in other areas can be applied to biosecurity.

It is also important to remember that other countries have biosecurity systems in place. We should learn from how they manage their biosecurity risks to use best international practice, and avoid duplicating research or repeating mistakes made elsewhere.

KEY ACTIONS TO MEET OBJECTIVE 1.12 ARE:

a. Assess the applicability of general risk-assessment and management theory and research to biosecurity.
b. Assess the potential applicability to biosecurity of risk management tools and practices in use in other sectors.
c. Review international risk-management models for biosecurity.

6.2 GOAL 2: SCIENCE DELIVERY. TO ENSURE WE HAVE THE CAPABILITY, CAPACITY AND RESOURCES FOR TIMELY AND EFFECTIVE DELIVERY OF BIOSECURITY SCIENCE

Having the appropriate scientific expertise and resources to address biosecurity threats is essential. New Zealand has considerable capability in biosecurity science and access to science providers internationally, but there are areas where capability and capacity are limited or non-existent, or where we are overly reliant on international expertise. The objectives identified for this goal address known capability and capacity gaps and ensure we have the right capability and capacity to help deliver biosecurity outcomes in the future.

OBJECTIVE 2.1: BUILD AND MAINTAIN BIOSECURITY SCIENCE CAPABILITY AND CAPACITY IN PRIORITY AREAS

Ensuring we have the right balance of skills to support the biosecurity system requires a clearer understanding of current capability, likely future needs and mechanisms to address the gaps. Work in this area will be ongoing and supported by the biosecurity science system described in Part Two; however, there are a number of areas already known to be deficient.

For example, capacity and capability are underdeveloped in the emerging areas of aquatic biosecurity, indigenous ecosystem biosecurity, and the human health impacts of plant and animal pests and diseases. Capacity and capability are also a particular concern for taxonomy and biosystematics, as biosystematics knowledge and skills provide an important foundation and support for much biosecurity work.

We need to strengthen the integration and application of other science disciplines and forms of knowledge into biosecurity management, such as the behavioural sciences, economics and mātauranga Māori me ōna tikanga. We also need to develop technological, engineering or business skills to commercialise science outcomes where appropriate.

KEY ACTIONS TO MEET OBJECTIVE 2.1 ARE:

a. Review, and increase our understanding of, New Zealand's current biosecurity science capability, including taxonomic and diagnostic capability.

b. Identify mechanisms to maintain capability where it is sufficient, and address any gaps that cannot be met from international networks.

c. Build capacity for human health, aquatic and indigenous terrestrial ecosystem biosecurity science – making use of existing non biosecurity-specific capacity in these areas.

d. Build capacity to apply social science and economics to biosecurity and to use technological, engineering or business skills to commercialise science outcomes.

e. Build research capability and capacity in mātauranga Māori me ōna tikanga and in integrating mātauranga Māori me ōna tikanga with biosecurity science, and build research capability of Māori in biosecurity science.

OBJECTIVE 2.2: PROVIDE EDUCATION AND TRAINING IN BIOSECURITY SCIENCE

A planned approach to biosecurity science education is critical to ensuring we develop appropriately trained professionals in the system. We want to make biosecurity science a career of choice and raise awareness of the breadth of biosecurity science and issues along with opportunities to work in this area in New Zealand. However, effort in this area should be targeted to

skills most needed, and where the largest gains can be therefore be made.

Some work is already under way in this area, such as the existing Centres of Research Excellence and the development of biosecurity courses and chairs of biosecurity science. However, better co-ordination is needed.

KEY ACTIONS TO MEET OBJECTIVE 2.2 ARE:

a. Identify and promote areas where science education and training will contribute most effectively to desired biosecurity outcomes.
b. Support development of biosecurity science education and training material and programmes in those areas where it will make the biggest contribution to desired biosecurity outcomes.
c. Identify and develop mechanisms to address education needs for Māori in relation to biosecurity science and mātauranga Māori me ōna tikanga pertaining to biosecurity science.
d. Develop targeted training programmes in biosecurity science for stakeholder groups.
e. Support the development in tertiary institutions of discrete courses, course components and programmes in biosecurity science.
f. Develop links between biosecurity agencies, research providers and tertiary institutions to increase understanding of the breadth of biosecurity science and promote biosecurity as an attractive career choice.

OBJECTIVE 2.3: FURTHER DEVELOP AND STRENGTHEN LINKS AND PARTNERSHIPS WITHIN NEW ZEALAND

Collaborative ventures are increasing in the delivery of biosecurity research, but many of these are split along sectoral lines. Collaborations within sectors are important but we also need to encourage cross-sector collaborations to draw on a wider pool of ideas, skills, knowledge and technologies.

Stakeholders, particularly research users and funders, need to work with providers to identify and resource priority science. Effective partnerships should lead to innovative science solutions to biosecurity problems, and will address the needs of government, industry and other stakeholders.

KEY ACTIONS TO MEET OBJECTIVE 2.3 ARE:

a. Build strategic research teams across the biosecurity system to undertake collaborative projects for priority research areas.
b. Build science–industry partnerships to enhance industry's ability to obtain science input into biosecurity planning and operations.
c. Develop mechanisms to encourage collaborative research partnerships and strengthen multidisciplinary links.
d. Build partnerships between science providers and Māori in planning, prioritisation and delivery of biosecurity science of particular relevance to Māori.

OBJECTIVE 2.4: FURTHER DEVELOP AND STRENGTHEN INTERNATIONAL LINKS AND PARTNERSHIPS

Significant opportunities exist for improved international collaboration in research planning and implementation. Many countries are investing significant resources into biosecurity science, and the research questions being asked are often similar. There are considerable efficiencies to be gained in co-ordinating research effort and combining outcomes from this research for improved biosecurity outcomes. Strong international relationships with our trading partners will enable us to identify and address biosecurity risks, and allow us to manage risks offshore where this is the best option.

Particular opportunities exist to collaborate with Australia on marine biosecurity and through an increased focus on science partnerships in the quadrilateral arrangements New Zealand has in place for terrestrial plant and animal biosecurity with Australia, Canada, and the USA. Opportunities also exist for collaboration on biosecurity science initiatives with the European Union (EU). Effective international partnerships will enable us to make the most of our finite biosecurity science resources and to draw on a much wider pool of knowledge and experience.

KEY ACTIONS TO MEET OBJECTIVE 2.4 ARE:

a. Strengthen links between New Zealand and international biosecurity science providers.
b. Further strengthen existing collaborative science planning and prioritisation through the quadrilateral group initiative (Australia, Canada, New Zealand and the USA) and with the EU for terrestrial animal and plant biosecurity.
c. Develop a closer partnership approach with Australia and other key countries for aligning and prioritising marine biosecurity research.
d. Develop partnerships and effective communication mechanisms with new and emerging trade partners to identify and address biosecurity risks, and develop co-operative relationships for biosecurity research, including through trade agreements.

OBJECTIVE 2.5: SUPPORT THE CONTRIBUTION OF MĀORI TO ACHIEVING BIOSECURITY OUTCOMES AND STRENGTHEN THE LINKS BETWEEN MĀTAURANGA MĀORI ME ŌNA TIKANGA AND BIOSECURITY SCIENCE

The understandings of taonga, traditional habitats, lifecycles and an underlying genealogical connection to native flora and fauna, are demonstrated within mātauranga Māori me ōna tikanga. This knowledge can work to inform biosecurity science in areas such as early warning systems of threats to native flora and fauna, and can provide an in-depth understanding of how the natural environment interacts with societies and communities.

KEY ACTION TO MEET OBJECTIVE 2.5 IS:

a. Develop mechanisms for retaining and promoting mātauranga Māori me ōna tikanga and its relevance and use in biosecurity management, consistent with Māori values.

OBJECTIVE 2.6: ENSURE THE RESOURCES AVAILABLE FOR SCIENCE ARE TARGETED TO BEST DELIVER BIOSECURITY OUTCOMES AND THE SCIENCE SYSTEM CAN ADDRESS BOTH SHORT- AND LONG-TERM NEEDS

As well as having the capability and capacity to deliver biosecurity outcomes we also need to make sure we are targeting resources, i.e. the people, funding and infrastructure required, to areas that will best deliver desired biosecurity outcomes. Biosecurity science needs can change rapidly in response to new biosecurity risks. The way that science is funded and managed needs to be sufficiently flexible to deal with high-priority short-term needs, while still protecting high-priority longer-term needs. The establishment of the biosecurity science system described in Part Two will be a key initiative to help address these issues.

Linking capability for delivering biosecurity science research with capability for delivering research in other areas such as biodiversity, public health, environmental management, climate change and primary production will have benefits in terms of economies of scale and enhanced capacity, which can be drawn on when necessary.

KEY ACTIONS TO MEET OBJECTIVE 2.6 ARE:

a. Ensure biosecurity research priorities and needs are linked with other broader initiatives such as ecosystem research, particularly at central government level, and between central and regional governments.

b. Encourage the use of multi-agency and multidisciplinary resourcing of biosecurity science where this could improve outcomes and uptake.

c. Build flexibility for delivery into research contracts to allow for short-term redeployment of staff during biosecurity emergencies if necessary, with minimal disruption to longer-term strategic work.

d. Identify and prioritise needs for new or improved biosecurity science facilities and related infrastructure.

e. Develop capacity in the system by ensuring biosecurity research capacity is closely integrated with related research, for example in areas such as taxonomy, biodiversity, horticulture, agronomy and animal production science.

6.3 GOAL 3: SCIENCE UPTAKE. TO ENSURE THAT UPTAKE OF SCIENCE IS TIMELY AND EFFECTIVE

Uptake of research and new technologies is often a neglected area. Lack of awareness of the research, lack of resourcing, incomplete research outcomes or research requiring further commercialisation before implementation is feasible, are some of the reasons for this failure. It is important to ensure that end-users and researchers communicate effectively, and that the potential benefits and applications of research are identified early. Addressing these issues will assist with integrating research into the biosecurity system, from policy through to operations.

OBJECTIVE 3.1: DEVELOP AND RESOURCE MECHANISMS FOR INCORPORATING SCIENCE OUTPUTS ACROSS THE BIOSECURITY SYSTEM AND ADDRESS OPERATIONAL BARRIERS TO UPTAKE

Uptake and implementation of research outcomes is at times overlooked in the competing priorities that need to be dealt with in the biosecurity system. A lack of resources for science providers, competing work priorities for policy and operational staff, or the need to further interpret or commercialise a research output for use by particular stakeholders are all reasons the uptake fails to occur.

We need to develop mechanisms that streamline the uptake of science and recognise it as a core component of biosecurity activities. Operational barriers for uptake include lack of awareness of research projects and programmes, lack of planning for approvals for new biosecurity tools (e.g. formal approvals required by the Environmental Risk Management Agency (ERMA) under the Hazardous Substances and New Organisms Act (HSNO) 1996), and intellectual property rights issues. These issues and others need to be managed, ideally at the project development stage.

Removing barriers to uptake will ensure opportunities to improve our biosecurity systems are not lost or delayed. We also need effective ways of communicating science outputs that suit the needs of different stakeholder groups.

KEY ACTIONS TO MEET OBJECTIVE 3.1 ARE:

a. Develop formal processes within biosecurity agencies for planning and resourcing the implementation of research outcomes.
b. Develop industry programmes to facilitate uptake of new biosecurity techniques or methods.
c. Improve uptake of biosecurity science by Māori and key stakeholders, by translating science outcomes into more targeted or user-friendly formats and languages.
d. Ensure that formal approvals and related requirements for biosecurity measures are included in science planning and delivery.
e. Identify opportunities for resourcing the technological development and commercialisation of research into operational tools.
f. Ensure that intellectual property rights and data access policies are clear and facilitate uptake.
g. Develop appropriate protocols and processes for the management of intellectual property issues related to mātauranga Māori me ōna tikanga and Māori culture.

OBJECTIVE 3.2: IDENTIFY OPPORTUNITIES FOR IMPROVED BIOSECURITY FROM NEW TECHNOLOGIES

New technologies have resulted in fundamental shifts in how biosecurity operates, e.g. the use of X-ray technology at the border. It is critical that we identify opportunities that new technologies provide. For example, biotechnology, nanotechnology and information technology are all areas where advances can give rise to significant opportunities for biosecurity. We also need to

ensure we are linked in with biosecurity-specific innovations internationally.

KEY ACTIONS TO MEET OBJECTIVE 3.2 ARE:

a. Build links with scientists who are working in areas closely associated with biosecurity to help identify biosecurity applications from innovations in new technologies.
b. Develop mechanisms to ensure we keep up to date with international innovations in biosecurity tool development that could be used to improve our biosecurity systems.

OBJECTIVE 3.3: DEVELOP AND ENHANCE MECHANISMS FOR EFFECTIVE COMMUNICATION BETWEEN SCIENCE PROVIDERS AND END-USERS

Effective communication between science providers and end-users during research, from planning through to operational implementation, is critical. This communication helps to ensure that science providers can plan ahead; that science outcomes are responsive to biosecurity needs; and ultimately, that the research is fit for purpose. While some mechanisms exist, these need to be further developed and enhanced.

Broad sharing of research outcomes also helps to identify new research needs and opportunities for uptake. Current mechanisms such as annual conferences, which focus on threats to plants, marine research or veterinary science, often include biosecurity content. Building the biosecurity focus of such conferences will encourage collaboration and sharing of ideas and research outcomes. There are also some cross-system biosecurity forums, although the content of such forums still tends to be arranged on sectoral lines. Forums need to be established that bring together people who work on the same issues from different perspectives, e.g. looking at surveillance from a marine, plant, animal, social and mātauranga Māori perspective.

To be effective, the actions below need to build opportunities for linking providers and end-users, and for developing communication and collaboration within and across sectors. The biosecurity science system described in Part Two will also be a key initiative in this area.

KEY ACTIONS TO MEET OBJECTIVE 3.3 ARE:

a. Develop and enhance ways for science providers to work closely with all end-users before and during the undertaking of research, and in developing plans for operational implementation.
b. Strengthen the focus on biosecurity of key existing forums and networks to improve communication of research outcomes to biosecurity science providers, funders and users.
c. Encourage sharing of biosecurity science information and its use across sectors and disciplines by establishing cross-sectoral forums, for example a biosecurity science symposium (or series of workshops) in conjunction with the annual Biosecurity Summit.

OBJECTIVE 3.4: DEVELOP SYSTEMS FOR EFFICIENT ACCESS TO UP-TO-DATE BIOSECURITY SCIENCE INFORMATION

Biosecurity science information is currently distributed in many unconnected databases and in both peer-reviewed journal articles and “grey” literature such as project reports. There is no single point of information on research priorities, research rounds relevant to biosecurity, current projects, or published information.

Effective uptake of science into all biosecurity activities, from operations through to international standard setting and trade negotiations, requires

that this information is easily accessible at international, national and regional levels. Easy access to biosecurity information is critical to ensuring that the best science can be used to inform biosecurity decision making and to reducing the risk of duplication. Information systems must enable efficient reporting and data retrieval relating to biosecurity risks to New Zealand.

KEY ACTIONS TO MEET OBJECTIVE 3.4 ARE:

a. Develop and adequately resource information systems which link relevant databases and other science outputs and knowledge systems to ensure easy access to biosecurity science information including:
   - international pests and diseases which are a risk to New Zealand;
   - pests and diseases already present in New Zealand;
   - susceptible or infected host species;
   - associations of pests and diseases with commodities;
   - pest or disease impacts;
   - relevant literature including published and unpublished reports;
   - management options, including surveillance and monitoring options;
   - published sources of mātauranga Māori me ōna tikanga and published information relating to Māori and biosecurity science.

b. Review regional databases on the distribution of diseases and exotic species and link these where appropriate.

c. Develop mechanisms to better integrate New Zealand systems and databases with international initiatives in biosecurity information management.

d. Improve access to taxonomic and biodiversity information through maintaining and enhancing national and international networks and information systems.

e. Improve the science content of the MAF Biosecurity New Zealand website to provide information on biosecurity science priorities and opportunities, including:
   - Biosecurity Science Strategy and strategy review;
   - upcoming research rounds;
   - current biosecurity initiatives;
   - completed project reports;
   - published reports;
   - science news;
   - conferences;
   - best practice examples of the application of biosecurity science;
   - links to databases and associated websites, including of CRIs, Māori research providers, universities and biosecurity-related science societies.

f. Develop a comprehensive and updateable list of biosecurity science providers and relevant expertise and, where appropriate, develop agreements for access to experts and a register for the agreements.

g. Develop easy-access systems for vouchering of biosecurity risk specimens and associated metadata.

STRATEGIC PRIORITIES

This Strategy has identified a number of key actions within 22 objectives which will help to achieve the Strategy goals. All of these objectives and actions are important for improving our biosecurity systems. As well as new initiatives, many of the actions identified are focused on improvements to existing tools or processes for delivery and uptake of science.

Together the actions form a strong basis for achieving the Biosecurity Science Strategy vision: "Biosecurity science is effectively contributing to keeping New Zealanders, the plants and animals we value and our unique natural environment, safe and secure from damaging pests and diseases."

This section identifies priority objectives and actions to guide planning and investment, recognising that our resources are limited and there is a need to provide clear signals of priorities. The proposed priority objectives and actions identified in this section are based on the current state of the biosecurity system. These priorities identify areas where we need to focus our investment, but should be considered in the context of the balance required for biosecurity science and in conjunction with the detailed descriptions provided in section 6.

The priority objectives represent general areas of work where effort needs to be applied to make a significant difference to the biosecurity system. The priority actions are more specific areas which require attention. In many but not all cases, the priority actions sit within the priority objectives.

In addition to the priorities listed here, the establishment of the biosecurity science system outlined in Part Two will be critical for the success of the Strategy and will underpin all goals. The priorities included in this section will be reviewed regularly through the biosecurity science system, recognising that some of the priority actions and even objectives will change over time.

The priority objectives and actions were developed by MAF Biosecurity New Zealand using five criteria:

- Strategic value: its alignment with government priorities, priorities for New Zealand, long-term benefits and whether multiple risks would be addressed in its implementation.
- Benefit-cost: considering environmental, socio-cultural, human health and economic costs and benefits.
- Practicality of carrying out the action, i.e. how urgent the action is and whether we have the capability to do it.
- Technical feasibility: how much it would cost, how long it would take and how difficult it would be.
- Acceptability: whether it is socially acceptable.

Each criterion was scored for all actions and objectives, aside from acceptability, which was used more as a check. Strategic value and benefit-cost were weighted more strongly given the strategic long-term nature of the document – twice that of practicality and technical feasibility. This assessment was undertaken with use of the Integrated Risk Management Framework (IRMF), which was developed as part of implementation of the Biosecurity Strategy[12]. The priorities were then reviewed through public consultation on the draft Strategy.

The final list of priority objectives and actions identified here are those which will make the biggest difference to the biosecurity science system, ensuring that science is effectively contributing to improving our biosecurity systems and we are prepared for the challenges of tomorrow.

[12] The IRMF was developed in 2004 by the biosecurity strategy implementation team – it has been reviewed and replaced with the Biosecurity Decisions Framework 2007. Future prioritisation will use this tool.

7.1 GOAL 1 PRIORITIES

GOAL 1: SCIENCE DIRECTION. TO CLEARLY IDENTIFY AND ADDRESS RESEARCH NEEDS.

The top priority objectives identified for goal 1 largely relate to improving information and tools to help mitigate risks to New Zealand before they reach our border, and to help secure the border. Focusing research on prevention is critical since the cost of mitigation generally increases as pests move across the border and become established (The Biosecurity Strategy, 2003). More effective and efficient surveillance, and eradication, containment and control tools are also critical.

Understanding risk pathways and social motivators, having more information on the characteristics of damaging pests and diseases, and developing methods for offshore treatments and risk management are all areas of research where science can make a significant contribution to ensuring biosecurity risks are understood, identified, minimised and appropriately managed. Similarly, future-watch activities which scan, analyse and disseminate information on emerging risks will help us to be more proactive in our pre-border management.

The top actions identified are drawn from a number of objectives, although the emphasis is clearly upon tools and knowledge to improve pre-border and border practices while maintaining other critical functions for the biosecurity system.

Priority objectives and actions (not in priority order) are:

- Forecast emerging biosecurity risks and develop contingency plans (objective 1.1), with a particular priority being to develop methods to better monitor and analyse trade patterns and the changing risk status of trading partners, and identify potential changes in the suite of pests and diseases and vectors that pose a risk to New Zealand (action 1.1.b).
- Understand the characteristics of high-priority pests and diseases (objective 1.2).
- Analyse risk pathways and vectors for entry and dispersal of priority pests and diseases (objective 1.3), with a particular priority being to increase understanding and characterisation of the pathways through which high-risk pests and diseases can enter New Zealand (action 1.3.a).
- Develop methods for managing risks offshore (objective 1.4), and in particular develop and/or validate both specific and broad spectrum tools which are cost-effective, safe and environmentally sound for managing risk offshore, either before departure or in transit (action 1.4.a).
- Develop enhanced tools for inspection and detection (objective 1.5).
- Develop new and improve existing identification and diagnostic tools for the border, post-entry quarantine and transitional facilities (action 1.6.a).
- Develop improved treatment technologies (objective 1.7), with priority on developing improved treatments for risk goods at the border and in transitional facilities, and developing methods to clean and treat vessels to minimise biosecurity risks associated with biofouling (actions 1.7.a and 1.7.b).
- Develop cost-effective surveillance tools and methods and apply within integrated surveillance systems (objective 1.8), with a particular priority being to develop more targeted and cost-effective surveillance and early detection techniques, including techniques designed to detect priority organisms that are difficult to detect or at low prevalence (action1.8.a).

- Develop a comprehensive understanding of human values and behaviours in creating and managing biosecurity risks (objective 1.10), with a particular priority being to identify current behaviours affecting biosecurity risk management for all sectors, reasons for that behaviour and the motivators, barriers and drivers relating to desired behaviours (action 1.10.b).
- Develop more cost-effective, socially and culturally acceptable, and humane tools and techniques to control, contain and eradicate pests and diseases where tools are limited (action 1.9.a).
- Develop robust tools to evaluate impacts on economic, environmental, social and cultural values for New Zealand's ecosystems (action 1.11. f).

7.2 GOAL 2 PRIORITIES

GOAL 2: SCIENCE DELIVERY. TO ENSURE WE HAVE THE CAPABILITY AND CAPACITY FOR TIMELY AND EFFECTIVE DELIVERY OF BIOSECURITY SCIENCE.

Good delivery of science requires sufficient capability, which takes time to develop, and the targeting of available resources to the greatest areas of need. These two requirements have been identified as priority areas under this goal. As a small country, developing and strengthening international relationships also has the potential to build capability and broaden our resource base.

The top actions identified under goal 2 focus on getting the capability and resource balance right and on strategic linkages, within New Zealand and internationally.

Priority objectives and actions (not in priority order) are:

- Build and maintain biosecurity science capability and capacity in priority areas (objective 2.1), with a particular priority being to review, and develop an understanding of, New Zealand's current biosecurity science capability, including taxonomic and diagnostic capability (action 2.1.a).
- Build strategic research teams across the biosecurity system to undertake collaborative projects for address high priority research needs (action 2.3.a).
- Further develop and strengthen international links and partnerships (objective. 2.4). Two actions of particular importance are: to strengthen existing collaborative science planning and prioritisation through the quadrilateral group initiative (Australia, Canada, New Zealand and the USA) and with the EU for terrestrial and plant biosecurity; and develop a closer partnership approach with Australia and other key countries for aligning and prioritising biosecurity science for marine biosecurity (actions 2.4.b and 2.4.c).
- Ensure the resources available for science are targeted to best deliver biosecurity outcomes and the science system is sufficiently flexible to address both short and long-term science needs (objective 2.6).

7.3 GOAL 3 PRIORITIES

GOAL 3: SCIENCE UPTAKE. TO ENSURE THAT SCIENCE IS RESPONSIVE TO BIOSECURITY NEEDS AND PRIORITIES AND THAT UPTAKE IS TIMELY AND EFFECTIVE.

The three objectives identified as the highest priority under goal 3 focus on access to science results and better communication between end-users and providers. Current knowledge and information often fails to be used because it is not readily accessible or easily understood. Systems which bring together biosecurity science information in a way that is accessible to users will make a significant contribution to improving biosecurity.

New technologies also have the ability to transform biosecurity risk management.

The top actions identified under goal 3 focus on easy access to biosecurity science outcomes and priorities, and addressing barriers to science uptake.

Priority objectives and actions (not in priority order) are:

- Develop formal processes within biosecurity agencies for planning and resourcing uptake or implementation of research outcomes (action 3.1.a).
- Develop industry programmes to facilitate uptake of new biosecurity techniques or methods (action 3.1.b).
- Identify opportunities for improved biosecurity from new technologies (objective 3.2).
- Develop and enhance mechanisms for effective communication between science providers and end-users for planning research and sharing research outcomes (objective 3.3).
- Develop systems to enable rapid and efficient access to up-to-date biosecurity science information, science priorities and opportunities (objective 3.4). Particular priorities are to develop and adequately resource an information system which links relevant databases and other science outputs and knowledge systems to ensure easy access to biosecurity science information, and to improve the MAF Biosecurity New Zealand website information on biosecurity science priorities and opportunities (actions 3.4.a and 3.4.e).

IMPLEMENTATION

AND REVIEW OF THE STRATEGY

8.1 IMPLEMENTATION

To improve the direction for, and delivery and uptake of, biosecurity science, the Strategy will need to be actively implemented. Engagement from biosecurity science providers, users and funders will be critical in achieving the vision of the Strategy. The first steps in implementation of this Strategy will be:

- broad communication of the Strategy by MAF Biosecurity New Zealand;
- development of an implementation plan by MAF Biosecurity New Zealand in consultation with stakeholders and Māori;
- determination of the “baseline” status and performance measures for each of the actions in the Strategy;
- establishment of the biosecurity science system with the necessary groups, terms of reference and mechanisms for collecting information.

8.2 REVIEW OF THE STRATEGY

Regular review of the Strategy will be important in ensuring that we are on track to meet the goals and objectives. Review will be undertaken at four levels as outlined in table 2.

A rigorous process to review and update the Strategy, by identifying and using meaningful performance measures, is critical for its success. For each action, a performance measure will be developed with an indicator and baseline. An example is provided in table 3. These performance measures will be specific, measurable, achievable, and time-bound to enable us to monitor how science is contributing to economic, environmental, social and cultural biosecurity-related outcomes. Performance measures for the actions will be included in the implementation plan to be developed by MAF Biosecurity New Zealand. Where possible the same performance measures or indicators will be used for multiple actions.

TABLE 3: EXAMPLE OF AN ACTION PERFORMANCE MEASURE

Action	Develop the procedures to be used by the forums for prioritisation of research needs and research uptake using the Biosecurity Decisions Framework (see Appendix B)
Baseline	Whether the procedures have been developed
Target date	June 2008

TABLE 2: REVIEW OF THE STRATEGY

TYPE OF REVIEW	TIME PERIOD	RESPONSIBILITY
Review of progress on implementation of actions	Annually	MAF Biosecurity New Zealand Strategic Science Team supported by MoRST
Review of priorities	Annually	MAF Biosecurity New Zealand through the biosecurity science system
Review of progress against strategy objectives	5-yearly	MAF Biosecurity New Zealand through the biosecurity science system
Review of Strategy as a whole	5-yearly	MAF Biosecurity New Zealand through the biosecurity science system

APPENDIX A:

ACTION PLAN

This appendix provides a proposed roll-out plan, timetabling all the actions in section 7 of the Strategy. The tables in the appendix provide a proposed action plan for the next 25 years. They provide guidance on when it might be desirable to increase effort or to start work on particular areas, given the relative urgency of the action and the time this is expected to take.

The roll-out plan is intended as a guide. It recognises that all the actions have a role to play in supporting the biosecurity system but they cannot be all implemented at once, as New Zealand's resources in terms of people and funding are limited.

Some actions need to precede others and some actions address a more urgent need in the biosecurity system (including the priorities identified). Some actions are long-term (i.e. will take some time to complete, or will require ongoing maintenance) but need to commence in the near future.

The tables should be considered indicative rather than prescriptive, as actions and priorities will need to be regularly reviewed through the biosecurity science system. Priorities will shift as actions are finalised, to reflect changes in society's values, due to technological advances and new tools, and due to increased knowledge about our environment and threats to it.

KEY FOR TABLES

= no work being done in this area (because it is not a priority at this time, it is reliant on other work being undertaken first, or the action should be completed).

= some work being done in this area or ongoing work required.

= focus and investment in this area required.

Priority objectives and actions from section 8 are identified by a ●.

GOAL 1 ACTION PLAN

GOAL 1: SCIENCE DIRECTION: TO CLEARLY IDENTIFY AND ADDRESS RESEARCH NEEDS

	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
OBJECTIVE 1.1 FORECAST EMERGING BIOSECURITY RISKS AND DEVELOP CONTINGENCY PLANS				
a. Identify emerging pests and diseases both nationally and internationally, and analyse the potential associated biosecurity risks and measures to manage these.				
b. Develop methods to better monitor and analyse trade patterns and the changing risk status of trading partners, and identify potential changes in the suite of pests, diseases and vectors that pose a risk to New Zealand.				
c. Analyse the potential biosecurity risks from increasing tourist numbers, changes in countries of origin of tourists, and changes in location and types of tourism activities.				
d. Develop methods to better monitor and analyse potential changes in biosecurity risks resulting from climate change.				
e. Analyse potential biosecurity risks and opportunities resulting from shifts in resource use and availability, such as energy or food resources, and from changes in transport technologies (domestically and internationally).				
f. Analyse the potential biosecurity risks and opportunities for risk management from changes in industry practices, such as the intensification of production systems.				
g. Assess the biosecurity implications of increased urbanisation and lifestyle changes of New Zealanders.				

	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
OBJECTIVE 1.2 UNDERSTAND THE CHARACTERISTICS OF HIGH-PRIORITY PESTS AND DISEASES				
a. Increase understanding of the biology, ecology and impacts of categories of pests and diseases, their relative biosecurity risks and the most effective points of intervention.				
b. Increase understanding of the epidemiology of zoonoses (diseases capable of infecting both humans and animals).				
c. Increase understanding of multi-species pest dynamics (population level interactions).				
d. Increase understanding of the mechanisms of virulence change.				
e. Increase understanding of lag times and the naturalisation process.				
f. Increase understanding of "invasiveness" and why some exotic flora and fauna establish and/or spread and others do not.				
g. Develop and test potential vaccines for potentially significant diseases for use on zoo animals and rare or endangered indigenous species.				
OBJECTIVE 1.3 ANALYSE RISK PATHWAYS AND VECTORS FOR ENTRY AND DISPERSAL OF PRIORITY PESTS AND DISEASES				
a. Increase understanding of the pathways through which high risk pests and diseases can enter New Zealand, including pest and disease vector/host/commodity relationships, to better characterise risk goods and the magnitude of risk associated with the pathway.				

	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
b. Increase understanding and characterisation of the natural and human-mediated pathways through which damaging pests and diseases can spread within New Zealand, and use vector and pathway analysis to identify the most effective points of intervention.				
c. Develop methods to trace incursions back to, and forward from, the source.				
d. Improve understanding of the factors which affect the probability of establishment, including the frequency of likely entry.				
e. Determine the potential for diseases, pathogens, and parasites associated with marine organisms to enter and establish in New Zealand.				
OBJECTIVE 1.4 DEVELOP METHODS FOR MANAGING RISKS OFFSHORE				
a. Develop and/or validate both specific and broad-spectrum measures, tools and strategies that are cost-effective, safe and environmentally sound for managing risk offshore, either before departure from the country of origin or while in transit.				
OBJECTIVE 1.5 DEVELOP ENHANCED TOOLS FOR INSPECTION AND DETECTION				
a. Develop improved tools for inspection and detection of biosecurity risks at the border, including tools to validate compliance of goods with official requirements.				
b. Develop inspection and detection tools to test the compliance of our exports with the biosecurity requirements of our trading partners.				
c. Develop alternatives to visual inspection for providing assurance of compliance with standards for both imports and exports.				

	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
OBJECTIVE 1.6 DEVELOP METHODS FOR RAPID IDENTIFICATION OF PESTS AND DISEASES				
a. Develop new and improve existing identification and diagnostic tools for the border, post-entry quarantine and transitional facilities, for imports and exports.				
b. Develop new and improve existing identification and diagnostic tools for surveillance and incursion response.				
c. Develop new and improve existing tools for the detection of genetically modified organisms.				
d. Identify priority biosecurity risk taxa for which taxonomic information is lacking and address gaps in information, including biosystematics research where necessary.				
OBJECTIVE 1.7 DEVELOP IMPROVED TREATMENT TECHNOLOGIES				
a. Develop improved treatments for risk goods at the border and in transitional facilities, including clear, scientifically-supported information on target organisms and details required for effective application, such as concentration/temperature/time data.				
b. Develop methods to clean and treat vessels to minimise biofouling and ballast risks – treatments should also be effective for any associated diseases and pathogens.				
c. Develop alternatives to methyl bromide and improve the use of existing fumigant treatments through better application, and methods for the safe destruction or recycling of fumigants after use.				
d. Develop new, and improve existing, post-harvest treatments for export commodities to increase cost-effectiveness and meet increasingly stringent environmental and human safety standards.				

	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
OBJECTIVE 1.8 DEVELOP COST-EFFECTIVE SURVEILLANCE TOOLS AND METHODS AND APPLY WITHIN INTEGRATED SURVEILLANCE SYSTEMS				
a. Develop more targeted and cost-effective surveillance and early detection techniques, including remote techniques and techniques designed to detect priority organisms that are difficult to detect at low prevalence.				
b. Develop or adapt surveillance tools and techniques for wider use within industry, agencies, and communities, including Māori groups.				
c. Develop integrated surveillance systems and the means to capture and interpret surveillance information from multiple sources (e.g. integrating 0800 number reports and veterinary reports with targeted surveillance for an animal disease).				
d. Develop robust methods for evaluating surveillance activities in terms of cost-effectiveness, sensitivity and probability of detection.				
OBJECTIVE 1.9 DEVELOP CONTROL, ERADICATION AND CONTAINMENT METHODS FOR POTENTIAL AND ESTABLISHED PRIORITY PESTS AND DISEASES				
a. Develop more cost-effective, socially and culturally acceptable, and humane tools and techniques to control, contain and eradicate pests and diseases, where tools are limited.				
b. Develop pest and disease management tools that minimise impacts on other species, particularly on threatened and taonga species.				
c. Develop methods to assess feasibility of eradication, containment or control.				
d. Develop methods to assess the impacts and effectiveness of pest and disease control programmes.				

	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
e. Develop integrated pest management approaches for priority pest groups, defined at an ecosystem/production system level, to reduce populations to below economic thresholds, and to safeguard environmental and human health.				
f. Develop effective, practical and acceptable alternatives to mass slaughter of production animals in response to incursions of serious livestock diseases.				
g. Develop methods for the safe disposal or treatment of infected organisms, equipment and facilities during an incursion response.				
OBJECTIVE 1.10 DEVELOP A COMPREHENSIVE UNDERSTANDING OF HUMAN VALUES AND BEHAVIOUR IN CREATING AND MANAGING BIOSECURITY RISKS				
a. Increase understanding of social and cultural attitudes towards, and understanding of, biosecurity risks and management measures, including the impact of changing demographics.				
b. Identify current behaviours affecting biosecurity risk management for different sectors, the reasons for that behaviour, and the motivators, barriers and drivers relating to desired behaviours.				
c. Increase understanding of the effectiveness of compliance tools and methods of modifying behaviours, such as sanctions, and the impact of improving the services provided by regulatory bodies.				
d. Increase understanding of behaviours associated with passenger and importer non-compliance with biosecurity requirements.				
OBJECTIVE 1.11 ASSESS THE ACTUAL AND POTENTIAL BIOSECURITY RISKS TO ECOSYSTEMS				
a. Increase understanding of, and develop methods to assess and predict the susceptibility of, indigenous ecosystems and species, particularly those which are threatened, to pests and diseases.				

	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
b. Increase understanding of the potential for taxa in New Zealand to act as hosts or vectors for exotic pests and diseases.				
c. Develop the ability to predict biosecurity risks to taonga and other culturally significant resources, and to determine the likely significance of the risk to tangata whenua and Māori organisations.				
d. Develop methods to assess interactions between different human impacts on ecosystems, and their relative risk, to improve targeting of management measures. (For example, assessing the interactions and relative risks of pests and diseases, pollution and changes in land or water use).				
e. Conduct targeted baseline studies of New Zealand's flora and fauna for priority unsurveyed areas or taxa.				
f. Develop robust tools to evaluate the impacts of biosecurity threats on economic, environmental, social and cultural values for New Zealand's ecosystems.				
OBJECTIVE 1.12 ASSESS APPLICABILITY TO BIOSECURITY OF DIFFERENT APPROACHES TO RISK MANAGEMENT				
a. Assess the applicability of general risk-assessment and management theory and research to biosecurity.				
b. Assess the potential applicability to biosecurity of risk management tools and practices in use in other sectors.				
c. Review international risk-management models for biosecurity.				

GOAL 2 ACTION PLAN

GOAL 2: SCIENCE DELIVERY: TO ENSURE WE HAVE THE CAPABILITY, CAPACITY AND RESOURCES FOR TIMELY AND EFFECTIVE DELIVERY OF BIOSECURITY SCIENCE

	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
OBJECTIVE 2.1 BUILD AND MAINTAIN BIOSECURITY SCIENCE CAPABILITY AND CAPACITY IN PRIORITY AREAS				
a. Review, and increase our understanding of, New Zealand's current biosecurity science capability, including taxonomic and diagnostic capability.				
b. Identify mechanisms to maintain capability where it is sufficient, and address any gaps that cannot be met from international networks.				
c. Build capacity for human health, aquatic and indigenous terrestrial ecosystem biosecurity science – making use of existing non biosecurity-specific capacity in these areas.				
d. Build capacity to apply social science and economics to biosecurity and to use technological, engineering or business skills to commercialise science outcomes.				
e. Build research capability and capacity in mātauranga Māori me ōna tikanga and in integrating mātauranga Māori me ōna tikanga with biosecurity science, and build research capability of Māori in biosecurity science.				
OBJECTIVE 2.2 PROVIDE EDUCATION AND TRAINING IN BIOSECURITY SCIENCE				
a. Identify and promote areas where science education and training will contribute most effectively to desired biosecurity outcomes.				
b. Support development of biosecurity science education and training material and programmes in those areas where it will make the biggest contribution to desired biosecurity outcomes.				
c. Identify and develop mechanisms to address education needs for Māori in relation to biosecurity science and mātauranga Māori me ōna tikanga pertaining to biosecurity science.				

	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
d. Develop targeted training programmes in biosecurity science for stakeholder groups.				
e. Support the development in tertiary institutions of discrete courses, course components and programmes in biosecurity science.				
f. Develop links between biosecurity agencies, research providers and tertiary institutions to increase understanding of the breadth of biosecurity science and promote biosecurity as an attractive career choice.				
OBJECTIVE 2.3 FURTHER DEVELOP AND STRENGTHEN LINKS AND PARTNERSHIPS WITHIN NEW ZEALAND				
a. Build strategic research teams across the biosecurity system to undertake collaborative projects for priority research areas.				
b. Build science–industry partnerships to enhance industry's ability to obtain science input into biosecurity planning and operations.				
c. Develop mechanisms to encourage collaborative research partnerships and strengthen multidisciplinary links.				
d. Build partnerships between science providers and Māori in planning, prioritisation and delivery of biosecurity science of particular relevance to Māori.				
OBJECTIVE 2.4 FURTHER DEVELOP AND STRENGTHEN INTERNATIONAL LINKS AND PARTNERSHIPS				
a. Strengthen links between New Zealand and international biosecurity science providers.				
b. Further strengthen existing collaborative science planning and prioritisation through the quadrilateral group initiative (Australia, Canada, New Zealand and the USA) and with the EU for terrestrial animal and plant.				

	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
c. Develop a closer partnership approach with Australia and other key countries for aligning and prioritising marine biosecurity research.				
d. Develop partnerships and effective communication mechanisms with new and emerging trade partners to identify and address biosecurity risks, and develop co-operative relationships for biosecurity research, including through trade agreements.				
OBJECTIVE 2.5 SUPPORT THE CONTRIBUTION OF MĀORI TO ACHIEVING BIOSECURITY OUTCOMES AND STRENGTHEN THE LINKS BETWEEN MĀTAURANGA MĀORI ME ŌNA TIKANGA AND BIOSECURITY SCIENCE				
a. Develop mechanisms for retaining and promoting mātauranga Māori me ōna tikanga and its relevance and use in biosecurity management, consistent with Māori values.				
OBJECTIVE 2.6 ENSURE THE RESOURCES AVAILABLE FOR SCIENCE ARE TARGETED TO BEST DELIVER BIOSECURITY OUTCOMES AND THE SCIENCE SYSTEM CAN ADDRESS BOTH SHORT- AND LONG-TERM NEEDS				
a. Ensure biosecurity research priorities and needs are linked with other broader initiatives such as ecosystem research, particularly at central government level, and between central and regional governments.				
b. Encourage the use of multi-agency and multidisciplinary resourcing of biosecurity science where this could improve outcomes and uptake.				
c. Build flexibility for delivery into research contracts to allow for short-term redeployment of staff during biosecurity emergencies if necessary, with minimal disruption to longer-term strategic work.				
d. Identify and prioritise needs for new or improved biosecurity science facilities and related infrastructure.				
e. Develop capacity in the system by ensuring biosecurity research capacity is closely integrated with related research, for example in areas such as taxonomy, biodiversity, horticulture, agronomy and animal production science.				

GOAL 3 ACTION PLAN

GOAL 3: SCIENCE UPTAKE: TO ENSURE THAT UPTAKE OF SCIENCE IS TIMELY AND EFFECTIVE

	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
OBJECTIVE 3.1 DEVELOP AND RESOURCE MECHANISMS FOR INCORPORATING SCIENCE OUTPUTS ACROSS THE BIOSECURITY SYSTEM AND ADDRESS OPERATIONAL BARRIERS TO UPTAKE				
a. Develop formal processes within biosecurity agencies for planning and resourcing the implementation of research outcomes.				
b. Develop industry programmes to facilitate uptake of new biosecurity techniques or methods.				
c. Improve uptake of biosecurity science by Māori and key stakeholders, by translating science outcomes into more targeted or user-friendly formats and languages.				
d. Ensure that formal approvals and related requirements for biosecurity measures are included in science planning and delivery.				
e. Identify opportunities for resourcing the technological development and commercialisation of research into operational tools.				
f. Ensure that intellectual property rights and data access policies are clear and facilitate uptake.				
g. Develop appropriate protocols and processes for the management of intellectual property issues related to mātauranga Māori me ōna tikanga and Māori culture.				
OBJECTIVE 3.2 IDENTIFY OPPORTUNITIES FOR IMPROVED BIOSECURITY FROM NEW TECHNOLOGIES				
a. Build links with scientists who are working in areas closely associated with biosecurity to help identify biosecurity applications from innovations in new technologies.				

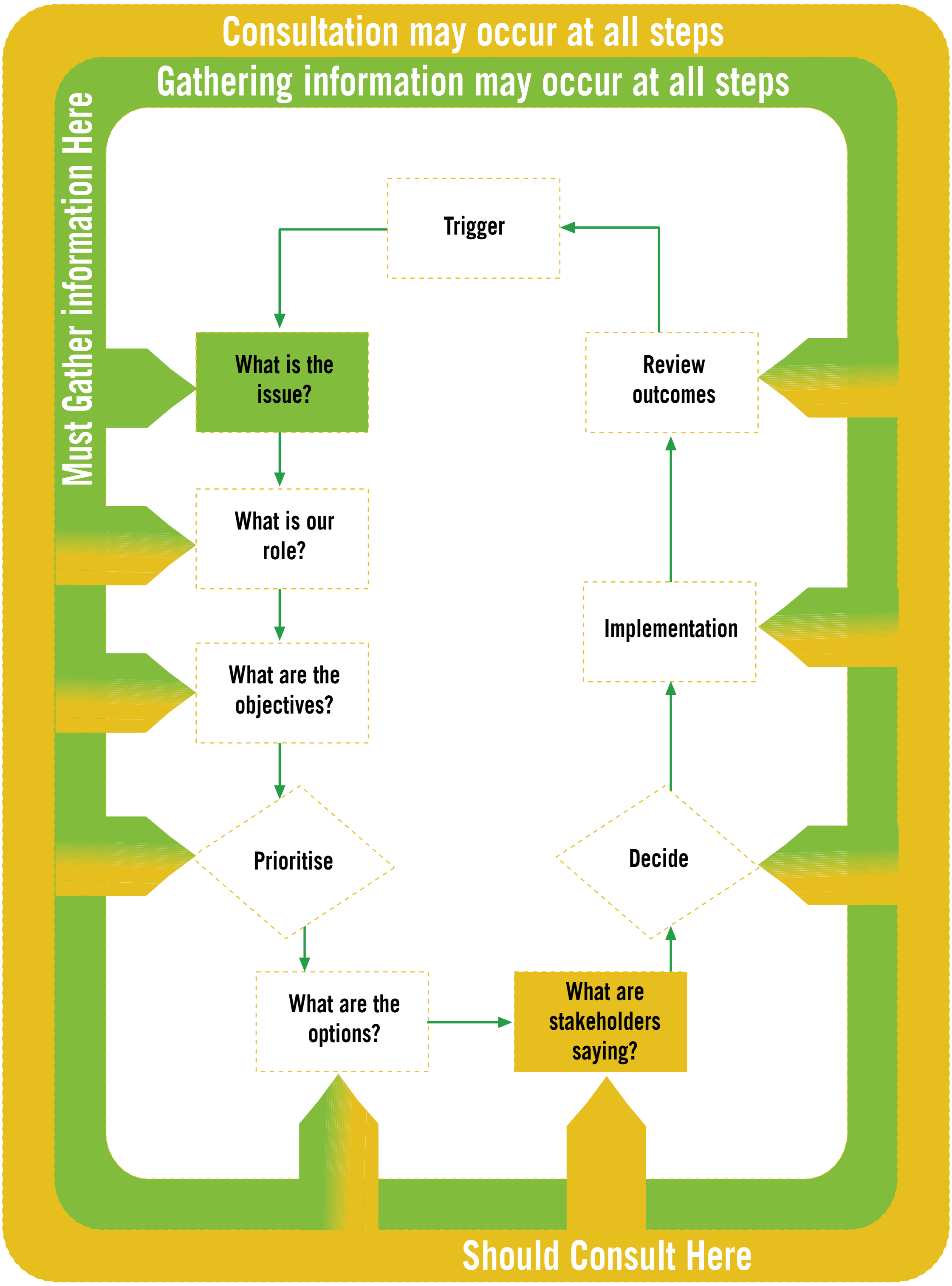
	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
b. Develop mechanisms to ensure we keep up to date with international innovations in biosecurity tool development that could be used to improve our biosecurity systems.				
OBJECTIVE 3.3 DEVELOP AND ENHANCE MECHANISMS FOR EFFECTIVE COMMUNICATION BETWEEN SCIENCE PROVIDERS AND END-USERS				
a. Develop and enhance ways for science providers to work closely with all end-users before and during the undertaking of research, and in developing plans for operational implementation.				
b. Strengthen the focus on biosecurity of key existing forums and networks to improve communication of research outcomes to biosecurity science providers, funders and users.				
c. Encourage sharing of biosecurity science information and its use across sectors and disciplines by establishing cross-sectoral forums, for example a biosecurity science symposium (or series of workshops) in conjunction with the annual Biosecurity Summit.				
OBJECTIVE 3.4 DEVELOP SYSTEMS FOR EFFICIENT ACCESS TO UP-TO-DATE BIOSECURITY SCIENCE INFORMATION				
a. Develop and adequately resource information systems which link relevant databases and other science outputs and knowledge systems to ensure easy access to biosecurity science information.				
b. Review regional databases on the distribution of diseases and exotic species and link these where appropriate.				
c. Develop mechanisms to better integrate New Zealand systems and databases with international initiatives in biosecurity information management.				
d. Improve access to taxonomic and biodiversity information through maintaining and enhancing national and international networks and information systems.				

	1–2 YEARS	3–5 YEARS	6–10 YEARS	10–25+ YEARS
e. Improve the science content of the MAF Biosecurity New Zealand website to provide information on biosecurity science priorities and opportunities.				
f. Develop a comprehensive and updateable list of biosecurity science providers and relevant expertise and, where appropriate, develop agreements for access to experts and a register for the agreements.				
g. Develop easy-access systems for vouchering of biosecurity risk specimens and associated metadata.				

APPENDIX B: BIOSECURITY

DECISIONS FRAMEWORK

BIOSECURITY DECISIONS STEPS



EXPLANATION OF THE BIOSECURITY DECISIONS STEPS

GATHER INFORMATION

Gather information throughout the whole decisions process, particularly to help define the issue and to identify and assess options.

CONSULTATION

Identify and consult affected parties as early as possible in the process and give sufficient time and information to affected parties. Where there is little information, consultation may need to be ongoing or occur at several points in the decisions process. Consultation may not be necessary in all cases.

CONSULTATION

- Who should be consulted?
- How should they be consulted?
- What is the objective of the consultation?
- What is the key information that needs to be provided?
- What is the scope/timeframe of the consultation?
- Do the expectations of those consulting/ those being consulted align with consultation objectives?
- What are the areas of concern identified?

TRIGGER

A trigger such as a 0800 call, an incursion, new information, or an Import Health Standard application should prompt the decisions process.

WHAT IS THE ISSUE?

Explain the background to the issue, including the nature and extent of the issue and the need for action.

NATURE OF THE ISSUE

- What is it?
- What is the underlying cause of the issue?
- What are the symptoms of the issue?
- What is the likelihood and consequence of the issue?
- What are the risks/opportunities?
- Has this been an issue in the past?
- How successful have we been at addressing it?
- What behaviours need to change?
- Who needs to change behaviour?

SIZE AND SCALE OF THE ISSUE

- How significant is the issue?
- What is the scope of the issue?
- Who is it an issue for?
- Does consultation need to occur to help define the issue/objectives?

NEED FOR ACTION

- What is the urgency/need for action?
- How reversible are the impacts of the issue?
- Are there any relevant government objectives/ outcomes?

WHAT IS OUR ROLE?

Clarify/agree who has the mandate/duty to act.

- Do we have a legislative requirement or prearranged role?
- Is it a pre-agreed role or responsibility of another agency?
- Who is best placed to solve it?
- Do we need to agree role division between MAF Biosecurity New Zealand and another agency?
- Who is best placed within MAF Biosecurity New Zealand to be responsible?

WHAT ARE THE OBJECTIVES?

Identify what needs to be managed to best achieve the outcomes. Clearly define the objective(s) to address the underlying cause of the issue in a way that does not pre-determine solutions, and is easily measurable. Clearly specify if objectives are subject to constraints such as time or resources.

- How will we measure success?
- What feedback is needed?

PRIORITISE RISKS AND OPPORTUNITIES

Rank the risks and opportunities of the issue against other issues and decide whether to continue analysis.

- Prioritise against strategic fit, net benefit, feasibility, resources, and barriers to success. For good practice prioritise using strategic fit and net benefit first to identify where the real risks and opportunities lie, and then consider feasibility, resources and barriers.
- What are the likely costs associated with maintaining the status quo?

WHAT ARE THE OPTIONS?

Develop, analyse and evaluate realistic options for achieving the objectives and that can be implemented.

DEVELOP OPTIONS

- What is the status quo?
- Is more information needed to inform development of options?
- Can the options be implemented?

ANALYSE OPTIONS

- What is the level of analysis required and timeframe?
- What are the costs and benefits of intervening/not intervening?
- Who benefits and who bears the cost of each option?
- How well do the options manage the risks?
- How will behaviours affect the level of compliance?
- Do the options address the underlying cause or the symptoms of the issue?
- What are the indicators for measuring success/ performance?

EVALUATE OPTIONS

- Prioritise options against strategic fit, net benefit, feasibility, resources, and barriers to success.
- What is the preferred option?

WHAT ARE THE STAKEHOLDERS SAYING?

Consult with affected parties even if you have already discussed the issue with them previously. Consultation must be genuine and feedback used to inform your decision. If you decide not to consult on the options make your reasons for this decision clear.

DECIDE ON AN OPTION

Choose an option, decide what we are going to do or not do, and clearly communicate the decision to affected parties.

IMPLEMENT THE DECISION

Develop an implementation plan and take action.

- Is a communication strategy required?
- What risks may affect successful implementation?
- What review mechanisms and performance targets are needed?

MONITOR AND REVIEW OUTCOMES

Monitor and evaluate performance, and review against the objectives. If recommendations from the review identify new information or issues these should feed back into the decisions process.

- How well does the decision meet the success/ performance criteria and objectives?
- How well does the decision respond to the risks, costs and benefits and public reaction to your actions?
- What are the intended/unintended effects of the action?
- What is the level of compliance?

Note that the dot points are intended to guide thinking, whereas the principles are compulsory.

BIOSECURITY DECISIONS PRINCIPLES

PROCESS PRINCIPLES

1. Follow the criteria and processes prescribed in relevant legislation and ratified international standards

Where legislation prescribes the process to be followed and/or criteria to be applied for a particular decision, these must be followed and applied. International standards or treaties that have been ratified by the Government must also be followed.

2. Analyse the issue before trying to find solutions

Spend time identifying the "real" issue, before thinking through solutions by:

- understanding and analysing: the issue, the context, the risks and opportunities and the objectives first; then
- thinking through solutions to manage the issue and assessing strategic fit, net benefit, feasibility, resources, and any other barriers for the solutions.

3. Decisions should be made by those best placed to do so

Unless specified elsewhere (such as in legislation), decisions should be made by the people who have the right information, skills and incentives as they are best placed to make good decisions in that area.

4. Timely and well-informed

There will always be uncertainty and lack of information, but we must make the best decisions we can with the best information available at the time. The level of information sought and analysis should be proportional to the size of the risk/opportunity identified in the available timeframe and the urgency required.

5. Consistency

Follow a consistent decisions process but only to the point where it is sensible to do so. Apply decisions principles, criteria and tools consistently so that decisions do not differ in assessment approach.

6. Consult affected parties, including Māori

Identify and consult those affected by our decisions, including Māori, as soon as possible in the decisions process. Give sufficient time and information to affected parties so they can provide effective feedback before final decisions are made, and so they can manage their own risks and interests at the same time.

7. Transparency

Tell affected parties, in plain language they can understand, what the decision is and the reasoning behind the decision so they understand the decision, the implications, and the behaviours being sought.

CONTENT PRINCIPLES

8. Decisions should aim to improve New Zealand's overall economic, social, health and environmental values

Decisions should be driven by the objective of securing positive consequences and limiting negative consequences for our economic, social, health and environmental values as a country, except where there are specific government objectives, directions or statutory requirements.

All decisions by the Government to intervene should be tested to check that the intervention is justified and delivers more benefits than costs.

9. Prioritise based on strategic advantage, technical feasibility, and net benefit

Prioritise using the following criteria, or develop and agree an alternative set of criteria before making the decision.

- Strategic fit – how well does it fit with the Government's biosecurity strategies and goals?

- Net benefit – what is the overall net benefit including costs, benefits and their likelihoods?
- Feasibility – is it feasible and what is the probability of success?
- Resources – what resources, skills and capabilities are required?
- Barriers – are there other barriers to success, such as the factors that cause public concern (coercion, unfairness, dread, etc)?

10. Uncertainty is not an excuse for inaction

Where there is uncertainty, decisions should focus on what reasonable steps can be taken at the time, while maintaining future options where appropriate and being transparent about the uncertainties and assumptions.

11. Irreversibility provides a stronger case for intervention

Where the impacts of not intervening are likely to be irreversible, there is a stronger case for intervention even when benefits only marginally outweigh costs.

12. Risks/opportunities should be managed by those best placed to do so

Those with the most appropriate incentives, capability, access to resources and the best information related to any specific opportunity or risk should manage those risks/opportunities.

13. Favour outcome-based over prescription-based interventions

Favour performance/outcome-based interventions over prescriptive interventions, wherever practicable and appropriate. Standards should be enforceable, and should draw on existing (industry) standards as much as is practicable to minimise compliance costs and allow innovation.

APPENDIX C:

GLOSSARY

APPLIED RESEARCH	Original investigation undertaken to acquire new knowledge, and directed primarily towards a specific practical aim or objective. It develops ideas into operational form. The results of applied research are intended primarily to be valid for a single or limited number of products, operations, methods or systems.
AQUATIC	In this document, for simplicity, "aquatic" refers to both marine and freshwater environments.
BALLAST WATER	Water, including its associated constituents (biological or otherwise), placed in a ship to increase the draft, change the trim or regulate stability. It includes associated sediments, whether within the water column or settled out in tanks.
BASIC RESEARCH	Experimental or theoretical work undertaken mainly to acquire new knowledge without any particular application for, or use in view. It analyses properties, structure and relationships with a view to formulating hypotheses, theories and laws.
BIOFOULING	The undesirable accumulation of micro-organisms, plants and animals on submerged structures.
BIOSECURITY	The exclusion, eradication or effective management of risks posed by pests and diseases to the economy, environment and human health.
BIOSECURITY SCIENCE	The science which underpins the biosecurity system and biosecurity decision making, and develops the knowledge and tools to undertake biosecurity-related activities.
BIOSYSTEMATICS	A branch of taxonomy based on the experimental study of the genetic and other properties of plant and animal populations.
CAPABILITY	Technical and technological ability, skills and knowledge for research, science and technology activities.
CAPACITY	The resources (human or other) required or available for research, science and technology activities.
COMMODITY	An article of commerce (e.g. a product of agriculture or mining), especially when delivered for shipment.
CRI	Crown Research Institute.
DELIMITING SURVEY	Survey conducted to establish the boundaries of an area considered to be infested by or free from a pest, or include the presence or absence of a disease.
ECOSYSTEM	A biological system comprising a community of living organisms and its associated non-living environment; interacting as an ecological unit.
EXACERBATOR	Those who create, continue, worsen or can control the biosecurity risks faced by New Zealand.
EXOTIC SPECIES	See Introduced species.

HAPŪ	Family or distinct groups, communities, a sub-tribe.
INDIGENOUS SPECIES	A plant or animal species which occurs naturally in New Zealand.
IN-KIND CONTRIBUTION	A non-cash input which can be given a dollar value, such as the provision of someone's time.
INTRODUCED SPECIES	A plant or animal which has been brought into New Zealand by humans, whether by accident or design. A synonym is 'exotic' species.
INCURSION	An occurrence of an organism not previously known to be established in New Zealand. Does not include interceptions at the border.
INTERCEPTION	Detection of an exotic organism at the border before it enters the country and becomes an incursion.
INTERNAL QUARANTINE	Measures put in place within New Zealand to contain an introduced species.
INTEROPERABLE	Pertaining to systems that work together or communicate.
KAITIAKITANGA	Often defined as guardianship, preservation, conservation, fostering, protecting and sheltering. The exercise of guardianship is based on the nature and sustainability of resources. It incorporates the spiritual as well as the physical responsibilities of tangata whenua.
KAITIAKI	The group or individual bestowed with undertaking the responsibilities of kaitiakitanga.
MĀTAURANGA MĀORI ME ŌNA TIKANGA	Mātauranga can be defined as the knowledge systems, values, concepts, world views that define Māori as a distinct social cultural group. Mātauranga Māori me ōna tikanga, then, are the knowledge systems and cultural practices that allow Māori to live, engage and interact with their environment and world.
OPERATIONAL RESEARCH	Research that feeds directly into management or operations.
PERFORMANCE INDICATORS	A measure (e.g. distance from a goal, target, threshold or benchmark) against which some aspects of performance can be assessed.
PEST AND DISEASE CONTROL	Reducing the unwanted damage caused by priority harmful organisms to natural resources by suppressing or reducing their incidence in New Zealand.
PEST AND DISEASE MANAGEMENT	Reducing the unwanted damage caused by priority harmful organisms to natural resources by eradicating, containing or controlling specific harmful organisms, preventing their general spread on priority pathways and vectors, or controlling them to protect specific sites.
REGIONAL PEST MANAGEMENT STRATEGIES	These are provided for by the Biosecurity Act 1993 and are established through a regional community consultation process which includes the community agreeing what their pest management priorities are, how the pests will be controlled, and how pest management will be funded.

SURVEILLANCE	Biosecurity surveillance is the collection, collation, analysis, interpretation and timely dissemination of information on presence, distribution or prevalence of pests, aetiological agents or diseases.
TANGATA WHENUA	Indigenous people to Aotearoa/New Zealand. Also means people of the land according to tribal and hapū custom.
TAONGA SPECIES	Culturally important species/treasures. Species of birds, plants and animals with which Māori have a recognised cultural, historic and traditional association.
TARGETED BASIC RESEARCH	Basic research undertaken with the expectation that it will produce a broad base or platform of knowledge likely to form the background to the solution of recognised or expected current or future problems or possibilities.
TAXA	Named biological classification units assigned to individuals or sets of species, for example species, sub-species, genus, or order.
TAXONOMY	The systematic classification of living organisms.
TRANSITIONAL FACILITY	Any place approved as a transitional facility in accordance with section 39 of the Biosecurity Act 1993 for the purpose of inspection, storage, treatment, quarantine, holding, or destruction of uncleared goods; or (b) A part of a port declared to be a transitional facility in accordance with section 39 of the Biosecurity Act 1993 [Biosecurity Act, S. 2].
VECTOR	An organism or object that transfers a pest or pathogen from one area or host to another.
VOUCHERING	Vouchering is the process of establishing voucher specimens. A voucher specimen is a specimen archived in a permanent collection such as a museum. It serves as physical evidence of occurrence at time and place and of any identifications and descriptions based on it, always assuming that it is archived with adequate collection data. Type specimens are voucher material.
WAAHI TAPU	Waahi tapu can be defined as sites and places sacred to Maori people, both tangible and intangible. Each Māori group will determine what a waahi tapu is to them. Waahi tapu can include (but are not limited to) pa; burial places; battlegrounds; reefs; springs etc.
WHAKAPAPA	Whakapapa is most often described as a person's genealogy, or family tree, linking that person to a particular family and/or ancestor. Whakapapa also explains the inter-connectedness of all living things.
WHĀNAU	Whānau links the people of one family to a common or important ancestor. It is most often used to describe the wider extended family.
ZOONOTIC	Pertaining to diseases transmitted to humans from animals.