How has ‘Operational Resource Calculator’ modelling contributed to biosecurity operational preparedness in New Zealand: A case study of the use of a Foot-and-Mouth Disease Operational Resource Calculator between 2011 and 2014

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Deirdre Nagle

Abstract/Summary

This dissertation is a case study reviewing how the use of Foot-and-Mouth Disease (FMD) Operational Resource Calculator model has contributed to developing biosecurity preparedness in New Zealand. The case study of the Biosecurity Response Services contract from 2011-2014 explores the preparedness themes from this period which are compared against the key themes from three New Zealand Emergency Events that occurred in the past five years. These themes are analysed and the role the Operational Resource Calculator in building biosecurity preparedness is explored. The findings from this case study identified that the use of the FMD Operational Resource Calculator has supported and guided the growth of the National Biosecurity Capability Network, helping to identify specific gaps in capability and target recruitment. The calculator has also enabled the capability within the National Biosecurity Capability Network for response operations to be tested and to measure capability in peacetime. This has proved important for political support of the network, trailing a potentially risky new model for operational biosecurity preparedness. In addition, the Operational Resource Calculator can be an iterative tool, therefore achieving longevity which can be utilised to measure capability against future FMD models developed for biosecurity response preparedness.

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Terms and Acronyms

AsureQuality	State owned Enterprise contracted to the Ministry for Primary Industries
BRS	Biosecurity Response Services
CDEM	Civil Defence Emergency Management
DEFRA	Department for Environment, Food and Rural Affairs
FMD	Foot-and-Mouth Disease
RFP	Request for Proposal
FMG	Foot-and-Mouth Preparedness Working Group
GDP	Gross Domestic Profit
MAF	Ministry for Agriculture and Forestry - the name is this Ministry was changed in 2012 to Ministry for Primary Industries
MCDEM	Ministry of Civil Defence Emergency Management
MOU	Memorandum of Understanding
MPI	Ministry for Primary Industries
NBCN	National Biosecurity Capability Network
NBCN IMS	NBCN Information Management System
NPV	Net Profit Value
UK	United Kingdom

Attestation of Authorship

"I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning."

Deirdre Nagle

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Introduction to the Topic

The use and efficacy of an Operational Resource Calculator to contribute to FMD preparedness is being reviewed due to a number of reasons; the first is the fact that the National Biosecurity Capability Network (NBCN) concept is an international phenomena. Secondly, the use of modelling and scenario development is an area which is usually related to risk analysis and decision making during responses while not presented in the literature as a preparedness tool.

I noted and observed that the ability to measure and benchmark response capability was driving the decision making for the Biosecurity Response Services programme of work over the 2011 to 2014 period. The Operational Resource Calculator was developed from a scenario and modelling process and enabled a realistic, albeit qualified target, to be established for the recruitment and development biosecurity operational response capability into the NBCN (Murray, 2011; Coombs, McMeekin, & Pybus, 1998). From this observation a question arose for the profession; what is the role and the significance, if any, of undertaking incursion modelling and scenario and developing Operational Resource Calculators to aid better biosecurity response operations preparedness. This research looks at understanding the role and the significance of undertaking incursion modelling and scenario development designed to aid better biosecurity response field operations preparedness

The research question 'How has 'Operational Resource Calculator incursion modelling' contributed to building biosecurity preparedness in New Zealand: A case study of the use of a Foot-and-Mouth Disease Operational Resource Calculator model between 2011 and 2014'. Therefore to understand the research question better several sub-questions were developed as follows:

a) Where does Operational Resource Calculator modelling fit in Biosecurity preparedness?

b) Does Operational Resource Calculator modelling have a role in other emergency preparedness areas?

c) How has operational resource modelling contributed to preparedness for Biosecurity

d) What are the learnings from the emergency events which have occurred in New Zealand around emergency preparedness?

e) How can mainstream emergency management learnings be integrated into the biosecurity preparedness space?

f) What are the recommendations for future use of the Operational Resource Calculator?

The interest in this topic has arisen from my move from working with Civil Defence Emergency Management into the biosecurity response management area. While in theory this is an area of emergency management, I was intrigued as to whether emergency management best practices are reflected in how preparedness or readiness priorities are set and how responses are managed. This is not the primary focus of this dissertation but remains a tangential interest. Learning from different New Zealand wide events and using these learnings across different emergency types is an interest to me because of the importance of the ability to overlay broad emergency management principles to specific emergency types like Biosecurity responses. This is considered important for future preparedness and increased improvement in response management and communities' recovery.

Previously, I have worked in International Development working in East Timor and Ecuador in the area of Food Security. I have worked in New Zealand as a project manager in community development and hold a volunteer position as Welfare Manager for Taranaki Civil Defence Group. Prior to working in Biosecurity I worked in partnership with Taranaki Civil Defence to develop emergency readiness/preparedness programmes for critical Social Service providers. I have worked for AsureQuality since March 2012 in the Preparedness and Response Programme Coordinator role from March 2012 until May 2014. I currently hold the position of National Biosecurity Surveillance Manager. During this period as Preparedness and Response Programme Coordinator, I managed the coordination of the implementation of the Biosecurity Response Services (BRS) contract which is the case study analysed in this piece of work.

There were some challenges experienced in development of this thesis; these challenges included working full time, being deployed to large scale responses e.g. Queensland Fruit Fly

in 2014 at the start of the year and ensuring transparency and managing biases and opinion. Working full-time while researching was the most significant challenge, but also the most beneficial to crystallising the layout and the content of this thesis. Due to the time taken from concept to final draft, an iterative process resulted, which was aided by my being part of the Biosecurity Industry and around professionals in this areas. Resultantly working full time, while limiting the time available to dedicate to the work, also helped broaden the scope of the thesis. Through access to professional connections this helped gain access to literature which would not ordinarily be accessed from the Ministry for Primary Industries. Transparency was addressed in some part from the use of the thematic coding analysis which helped develop a distance from the content of the results and enabled objectivity in the analysis. In addition, my leaving the position of Preparedness and Response Programme Coordinator in May 2014 has enabled further distance away from the contract and less ownership of the material which has helped in the analysis and discussion section and supported more robust recommendations. While I have declared a vested interest in biosecurity preparedness and could potentially bring a number of biases to this work, the knowledge, experience and commitment that I bring to transparency help balance this risk.

This work is embargoed for the next 5 years of the BRS contract; this was a provision for formal permission from the AQ Management to use the Biosecurity Response Services contract material for this case study. This is embargoed due to the commercially sensitive nature of the contract material; however this does not negate a report arising from this thesis for AsureQuality and MPI who are the respectively the contractor and the contract owner.

1.2 Thesis structure

The following section sets out the structure for this thesis.

Chapter 1 Introduction

Chapter 1 provides an introduction to this thesis, with a profile of the author and the reasons for the choice of this topic. The challenges experienced are briefly covered.

Chapter 2 Literature review

This chapter consists of a literature review which starts with the Three New Zealand Events in the past five years, The Pike River Mine Tragedy 2010, The Christchurch Earthquakes 2011 and 2012 and the 2010 PSA Kiwifruit Biosecurity Response, an introduction to Foot-and-Mouth Disease and a review of the use of Biosecurity Response Modelling.

Chapter 3 Methodology

This chapter is a discussion of the methodology, the research design and research methods employed to undertake the case study and thematic analysis. The reasons for this choice of methodology are reviewed; the alternative options considered are presented.

Chapter 4 Results

The results from the Three New Zealand Emergency Events in the past five years and the Biosecurity Response Services Case Study 2011-14 are presented in Chapter 4. These results are presented in concurrent sections in the Results chapter.

Chapter 5 Analysis

In Chapter 5, the analysis of the findings from the Three New Zealand Emergency Events in the past five years and the Biosecurity Response Services Case Study 2011-14 are compared and contrasted.

Chapter 6 Discussion

In the Discussion chapter the role of the use of the Operational Resource Calculator is discussed. The salient aspects which effect biosecurity response preparedness are discussed. .

Chapter 7 Recommendations

In the final Recommendations chapter, five recommendations are made which relate to how best develop future biosecurity preparedness. Some of these recommendations relate directly to the use of the Operational Resource Calculator and some do not.

Literature Review Introduction

Introduction

Three New Zealand events which have impacted on the social, infrastructural and economic fabric of New Zealand are profiled; these are the Christchurch Earthquake 2011, Pike River Mine Tragedy 2010 and the PSA Kiwifruit Biosecurity Incursion in 2010. The motivation and reason for looking at these three events are lessons which could be applied to the model to prepare for another major event which could affect the New Zealand Economy, which is Foot-and-Mouth Disease, referred to as FMD. The purpose of this dissertation is to not explore the events themselves but to demonstrate how these events have affected New Zealand and extract the learnings to improve future biosecurity preparedness.

This literature review is structured in three sections. The first section looks at three major emergencies which have occurred in New Zealand in the past five years from 2010 to 2014. The second section moves on to introduce concepts of Biosecurity, Foot-and-Mouth Disease (FMD) and the 2001 UK FMD response and the use of modelling for biosecurity responses. In the final literature section, section three, the development of operational resource capability modelling is introduced which is the topic for the case study. Modelling is profiled in this section to put this piece of work in context of overall biosecurity response management. The use and efficacy of Operational Resource Calculator modelling is the main focus of this dissertation.

Three significant examples of the major emergencies which have occurred in New Zealand over the past five years have been explored to try and identify the learnings arising from each of the resultant reviews and the various Commissions' reports which pertain to emergency preparedness. These learnings will be used as part of the analysis framework from the case study on the biosecurity Response Services (BRS) contract for biosecurity preparedness work, which will be reviewed to understand the role of Operational Resource Calculator and resultant benefits or other to biosecurity preparedness. The reasons for choosing to review such a breadth of emergency related incidents is to identify whether there is a universal relationship around preparedness focusing on understanding the operational resourcing needs wider than the area of biosecurity emergency preparedness. In addition, these key learnings of broad emergency management principles and learnings are being applied to this Foot-and-Mouth Disease (FMD) biosecurity focused case study.

Review of Three Major Emergency Events in New Zealand in the past five years 2009-2014

The following discussion focuses on three major disasters experienced in New Zealand in the last five years: the Christchurch Earthquakes 2011 and 2012, and The Pike River Coal Mine Tragedy 2010. Due to the breadth of these events this literature section will summarise the recommendations and learnings from the 2012 Royal Commission Report on the Pike River Mine Tragedy in 2011 (Royal Commission, 2012) and the Christchurch Earthquake Commission's Report (MCDEM, 2012a) and compare these to the recommendations from the PSA Kiwifruit Response Assessment Report, MAF, 13 October 2011 (MAF, 2011) to extract the common themes from these events which relate to response preparedness.

Pike River Coal Mine Tragedy, 19 November 2010

On Friday 19 November 2010 at 3:45pm there was an underground explosion at the Pike River coal mine. Twenty-nine men lost their lives, and their bodies have not been recovered. Two men survived the explosion. They were in the stone access tunnel (drift), a distance from the pit bottom area where the main workplaces were located. Although initially overcome, Daniel Rockhouse rescued himself and his colleague, Russell Smith (Royal Commission, 2012a).

The New Zealand Police led the emergency response that involved emergency services, and mines rescue crews from New Zealand, New South Wales and Queensland. Despite strenuous efforts by everyone involved, a lack of information concerning the conditions underground prevented a rescue attempt (Royal Commission, 2012a).

A second explosion on Wednesday 24 November extinguished any hope of the men's survival. The emergency focus changed to recovery of the bodies (Royal Commission, 2012a).

The financial and social impacts of the 2010 Mine disaster which were located around the West Coast town of Greymouth are difficult to directly quantify, but the Pike River Mine itself pumped over $80 million dollars a year into the Greymouth community, and $13million

of this was directly into wages (Royal Commission, 2012a). In a population of 13,650 (Statistics NZ, 2014) this is significant.

On 29 November 2010 the Prime Minister announced the government's intention to establish a royal commission. In December 2010 the Royal Commission's terms of reference and the appointment of three commissioners, the Hon. Graham Panckhurst, David Henry CNZM, and Stewart Bell PSM, the Commissioner of Mine Safety and Health for Queensland, were announced. In broad terms the Royal Commission was required to report on:

- the cause of the explosions and the loss of life;
- why the tragedy at Pike River occurred;
- the effectiveness of the search, rescue and recovery operation;
- the adequacy of New Zealand mining law and practice and the effectiveness of its administration; and
- how New Zealand mining, and associated conservation and environmental, law and practice and its administration compares with that in other countries (Royal Commission, 2012a).

The commission was also asked to make recommendations about the prevention of mine disasters, the improvement of search, rescue and recovery operations, any necessary changes to mining law and practice and how to make the Pike River mine safe should it not be reopened (Royal Commission, 2012a). There are a series of recommendations made from the 2012 Royal Commission Report on the Pike River Mine Tragedy; (Royal Commission, 2012a)[1].

Christchurch Earthquake, 22 February 2011

The Christchurch earthquake of 22 February 2011 caused tragic deaths and injuries; this resulted in severe damage to tens of thousands of homes and the devastation of the city of Christchurch central business district (CBD) which in 2014 is still in the process of being rebuilt. The response to this event posed an unprecedented challenge for civil defence emergency management in New Zealand (McLean, Oughton, Ellis, Wakelin & Rubin 2012).

[1] For further information refer to the following websites:
http://pikeriver.royalcommission.govt.nz/Volume-One---What-Happened-at-Pike-River
http://pikeriver.royalcommission.govt.nz/Volume-One---What-Happened-at-Pike-River---Part-Two
http://pikeriver.royalcommission.govt.nz/Volume-One---Recommendations

185 deaths occurred, or would later occur as a result of injuries. Of these 169 were known to be people in the CBD at the time of the earthquake. Many more were injured. Over 26000 houses were left vacant, with 12,069 students from the Canterbury region re-enrolled in other schools around the country a total of 15.9 per cent of total enrolments for the region from prior year (McLean et al. 2012). Total migration (from NZ Post data) indicates that approximately 8,632 households and 24,892 people (including 2,268 children) from within the Canterbury region re-located their place of residence (if only temporarily) during the 6 weeks from 23rd February (McLean et al. 2012) and 8,900 permanently left the city (NZ Parliament Website, 2014).

The New Zealand Treasury's assumption is that the rebuild cost for the Christchurch earthquake will cost the equivalent of around 10 per cent of Gross Domestic Product (GDP), which represents a 'very large shock' in relative terms. As a comparison, the March 2011 earthquake and tsunami in Japan is estimated to have caused damage equivalent to around 3 to 4 percent of Japan's annual GDP. Damage estimates have been estimated up to $30 billion if business disruption or additional costs from inflation, insurance administration or rebuilding to higher standards than before the earthquake are included. This includes $13 billion for the residential sector, $4 billion for the commercial sector and $3 billion for infrastructure. The estimated total net cost to the Crown is now $13.5 billion (NZ Parliament Website, 2014)[2].

The Ministry of Civil Defence & Emergency Management (MCDEM) commissioned an independent review of the civil defence emergency management (CDEM) response to the February 2011 Christchurch earthquake. The purpose of the review was to identify, from an emergency management perspective, the practices that should be reinforced and the processes and policies that need improving. It focused on the emergency response and how well the response arrangements in the National CDEM Plan worked (MCDEM, 2012).

[2] For more detailed information on the event itself and the recovery activities and statistics see the following websites; http://www.parliament.nz/en-nz/parl-support/research-papers/00PlibCIP051/economic-effects-of-the-canterbury-earthquakes http://www.civildefence.govt.nz/memwebsite.nsf/wpg_URL/For-the-CDEM-Sector-Publications-Review-of-the-Civil-Defence-Emergency-Management-Response-to-the-22-February-Christchurch-Earthquake?OpenDocument http://www.rbnz.govt.nz/research_and_publications/reserve_bank_bulletin/2012/2012sep75_3parkersteenkamp.pdf

PSA Kiwifruit Response, November 2010

In November 2010 the virulent bacterial Disease, Pseudomonas syringae pv. Actinidiae (PSAV) was first found on a New Zealand kiwifruit orchard. In the early stages of the disease outbreak, Government contributed $25 million, matched dollar for dollar by industry, for the management of PSA (MPI 2014).

The financial impact of the Disease in the Kiwifruit industry has been estimated from $310-$410m over 2010-2015 and $500-$600m over a ten year period and up to $885m over fifteen years directly to the industry itself (Greer & Saunders, 2012). In addition the loss of vines has led to a loss of $900m and 1250 orchards have been identified with the virus. Just under fifty per cent of New Zealand's Kiwifruit orchards are currently affected by PSA. Land prices have also been affected, reduced values from $400-$450,000 per hectare to yields of in and around $70,000 per hectare (Greer & Saunders, 2012).

The Minister for Primary Industries declared PSA affecting North Island kiwifruit growers as a medium-scale biosecurity event under the Government's Primary Sector Recovery Policy in December 2012. The declaration means the Government will fund provision of services to help affected growers deal with the impacts of the incursion, and the hardest hit growers could be eligible for payments (MPI, 2014).[3] The Ministry for Primary Industries, formerly MAF, published a Response Assessment Report following the bacterial kiwifruit vine disease the PSA Kiwifruit Response Assessment Report, MAF, 13 October 2011 (MAF, 2011). This report identified that a number of areas of improvement could have supported a better operational response performance.

[3] For more detail and reports on this response see the following website.
http://www.biosecurity.govt.nz/pests/kiwifruit-vine-Disease

Introduction

The following section will introduce concepts of biosecurity, Foot-and-Mouth Disease (FMD) and the use of modelling for biosecurity responses. Due to the scope of this dissertation, this is a brief introduction to these topics, covering the most significant areas which pertain to the research question.

Biosecurity Emergency Management

Biosecurity is defined by the New Zealand government as the protection of New Zealand's economy, environment and people's health and social and cultural wellbeing from pests and Diseases (MAF, 2012 p.2). The process of biosecurity includes trying to prevent new pests and diseases arriving, and eradicating or controlling those already present (MAF, 2012 p.2). 'Biosecurity is vitally important to New Zealand because of the country's reliance on agriculture, the significance of the natural environment, market value of natural resources, and the unique native species' (MAF, 2012 p.3). The Ministry for Primary Industries (MPI, formerly MAF) is the government agency responsible for ensuring biosecurity services are provided in New Zealand from pre-border, border, post-border surveillance and managing biosecurity responses. The Ministry for Primary Industries (MPI) contracts AsureQuality[4] to undertake biosecurity response field operations.

The biosecurity system requires the involvement of central government agencies, territorial and regional authorities, growers associations and wider biosecurity stakeholder groups with diverse interests and requirements. The current Biosecurity Response Contract 2009-2019 between MPI and AsureQuality has resulted in the development of a generic response management approach which aims to develop capability for any and all biosecurity incursion response types (MAF 2012). This change in 2009 replaced the previous specific response type focus e.g. animals or plants. This previous preparedness method focused response preparedness approaches on developing response capability for each response type, where structure and procedures were kept separate. This shift, from specific to generic response preparedness in biosecurity response policy, has resulted in the identification of generic capability required for a large scale response. This change to generic capability has led to the concept of the National Biosecurity Capability Network (NBCN) which focuses on the use of generic capability and skills which already exists in

[4] Refer to http://www.asurequality.com/a-world-class-provider-of-food-safety-and-biosecurity-services.cfm

commercial New Zealand to increase the level of existing biosecurity response preparedness. The purpose of this new government approach was to ensure that existing capability resources can be scaled up or down as appropriate for almost any threat or situation and that the capability can be utilised for different incursion types using resources more effectively (MAF, 2009).

This has been a significant paradigm shift for biosecurity response preparedness, where previously response capability was built separately for each response type, this capability is now combined. In addition, accessing existing resources which exist in commercial New Zealand through the National Biosecurity Capability Network is a significant change to the previous standing army approach employed in the old Field Operations Response Training (FORT) contract held with AsureQuality until 2009 (Murray, 2014). This shift can be analgised to the change in Civil Defence Emergency Management Act in 2002, where Civil Defence moved from be armed to respond to a civil emergency to coordinating the resources to respond (CDEM, 2002).

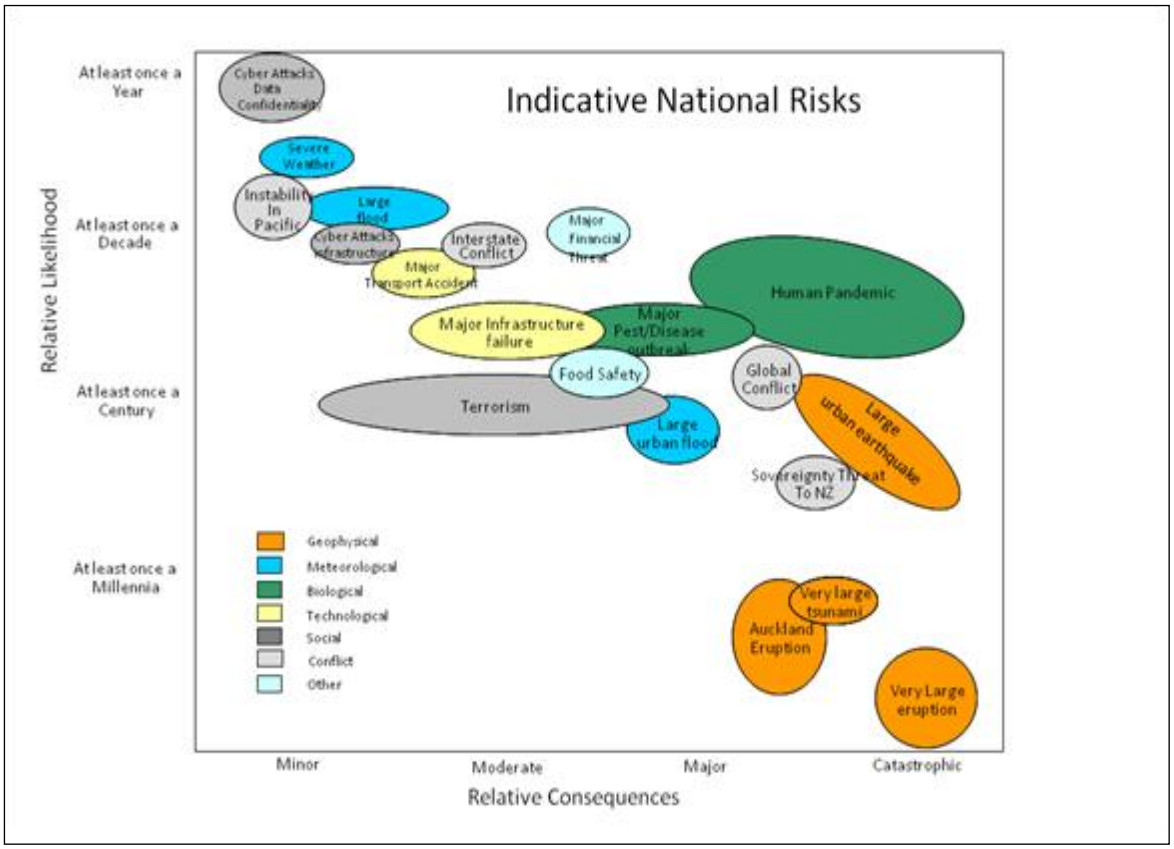

Figure 1: Indicative National Risks in NZ Department of Civil Defence Emergency Management (CDEM, 2012)

Foot-and-Mouth Disease

Foot-and-Mouth Disease (FMD) is a highly contagious viral disease that can infect all species of cloven-hoofed animals. It is rarely fatal to adult animals, but high mortality is common in young animals. Symptoms include fever and blister-like sores on the tongue and lips, in the Mouth, on the teats and between the hooves. The disease causes severe production losses and while many affected animals recover, the disease often leaves them weakened and debilitated (Forbes & van Halderen 2014 p.9).

Key points to note about FMD are:

a. FMD does not affect humans, and there is no food safety risk associated with consuming products from animals infected with FMD.

b. The organism which causes FMD is a virus from the family *Picornaviridae.* Seven strains of the virus are known.

c. There are countries which are free from FMD countries and also there are zones with or without vaccination (Forbes & van Halderen 2014 p.9).

Countries that are free of FMD have traditionally responded to outbreaks of FMD through so-called "stamping out", a policy that is defined by the Official Information Enquiry (OIE) and referenced in trade agreements. Stamping out is the cornerstone of New Zealand's current FMD policy. MPI would lead the response using powers under the Biosecurity Act 1993. The aim would be to regain FMD-free country status with minimum delay (Forbes & van Halderen 2014 p. 11).

Foot-and-Mouth Disease is considered by far the most serious of all animal's infections owing to its rapid transmission between a wide range of livestock species. In general, Foot-and-Mouth Disease (FMD) is rarely fatal to adult livestock, but causes blisters on the mouth and feet and a deterioration of condition, often leading to a dramatic decline in milk production in dairy cattle and very slow weight gain in other livestock (Alexandersen, S., Quan, M., Murphy, C., Knight, J. & Zhang Z., 2003). In addition, the economic consequences of infection within a country are severe, preventing the export of meat and milk to many regions of the world, thus eliminating a vital source of revenue. Therefore, following detection, the main aim of any control policy is to achieve Disease-free status as quickly as possible (allowing exports to resume), with the minimum of impact on the livestock community (Keeling, 2005). Unfortunately, according to Keeling (2005) these two

motivating ideals of minimizing the time and minimizing the disturbance are often in conflict. The potential impact of FMD is massive as was illustrated in an outbreak in the UK in 2001 (Forbes & van Halderen 2014).

UK 2001 FMD Outbreak

The 2001 FMD outbreak in the United Kingdom (UK) resulted in four million FMD-susceptible animals on 10,157 premises being slaughtered. There were 2,026 premises declared infected, 4,762 premises were considered dangerous contacts of infected premises and 3,369 premises were located near to infected premises. A further 2.5 million animals were slaughtered for reasons of welfare such as overcrowding and compromised nutrition. The official figure for the number of animals slaughtered was approximately 6.5 million, but when the total number of still-suckling lambs, calves and pigs that were slaughtered is included, the total could be as high as ten million (Kitching, Thrusfield & Taylor, 2006). The financial cost of the FMD Epidemic in the UK (including Northern Ireland where four premises were infected) was over NZD$15.5 billion, this included NZD$5.8 billion in losses sustained by the leisure and tourist industry. However, the social cost evidenced by the many newspaper reports and submissions to the various inquiries conducted after the epidemic could not be quantified (Kitching, Thrusfield & Taylor, 2006).

During the 2001 Foot-and-Mouth Disease outbreak in the UK, three very different models were employed in an attempt to predict the disease dynamics and inform control measures. In spite of the differences in the models, all three of the models made similar predictions about the types of controls that were required to prevent the FMD epidemic from spreading (Keeling, 2005). Each of the three models had shortcomings which had a direct impact on the policy decisions which governed the animal destruction and disposal methods employed by the response operations teams to deal with the outbreak.

These three models employed in the 2001 UK FMD response are being presented in this work as an example of how modelling has been used for an FMD response in the past and how models can determine response operations decision making. When the FMD epidemic was first detected in the UK in February 2001, the InterSpread model used by the Department for Environment, Food and Rural Affairs (DEFRA) was the only viable means to predict the spread of this infection. InterSpread is a large, complex and very flexible stochastic

simulation model[5] capable of predicting the spread of infection influenced by many different factors. The Disease predictions from this model were aligned and in qualitative agreement with the spatial and temporal pattern of the actual cases of Disease observed in 2001 UK FMD response (Stevenson 2003 cited in Keeling 2005). From the information which was outputted from this Interspread model the breadth of animal culling performed during 2001 was deemed necessary (Morris *et al*. 2001 cited in Keeling 2005). The number of animals destroyed during the UK FMD response was a matter of contention which will be referred in the following sections.

The second model, the Cambridge–Edinburgh model, is an explicit spatial model which is initialized with the location of all farms in the UK and their livestock as recorded at the last census. As such, the starting conditions are the same as those of InterSpread, but due to the fact that the Cambridge–Edinburgh model has a more simple and transparent transmission of Disease mechanism, this lead to fewer parameters being utilised to model the path of Disease. The reason this was important was that this meant that the formulation and assumptions were more transparent and therefore more open to scientific scrutiny using this model (Keeling, 2005). According to Keeling (2005) if faced with another outbreak, this Cambridge–Edinburgh model could be re-parameterized to reflect the epidemiological characteristics of the invading FMD strain (Keeling, 2005).

A third model utilised in the UK FMD response in 2001 was the Imperial Model. This model treats the farm as the individual unit and classifies each farm by its infectious status (Kermack & McKendrick, 1927 cited in Keeling, 2005). The Imperial Model was formulated during the first few weeks of the UK FMD epidemic which while crude, provided a necessary approximation for the transmission of the Disease. The significant element in this was model was that it ignored farm differences and only differentiated between local and long-range Disease transmission (Ferguson *et al*. 2001; cited in Keeling 2005). This was a limiting factor in this model due to how the FMD Disease can interact with different farm types.

The result of the outputs from the three predictive models profiled above was to manage the UK 2001 FMD incursion Disease control through pre-emptive animal culling of susceptible animals. The three models utilised; the InterSpread, Cambridge-Edinburgh and the Imperial

[5] Stochastic modelling is used for the purpose of estimating the probability of outcomes within a forecast to predict what conditions might be like under different situations

model predicted to have a higher probability of farms becoming infected than transpired in reality. There was no check and balance requirement to assess whether the outputs from the models which predicted the likelihood of Disease transmission was reflecting what was being actually being experienced in real cases at the time. The resultant tactic for Disease control employed in the UK in 2001 lead to the destruction of many healthy animals, which in turn posed major logistical problems for the disposal of animal carcasses, and the disposal of many using pyres was very socially unpopular (Kitching, Thrusfield & Taylor, 2006).

The decision to dispose of so many animals was the direct result of the output from the Disease modelling; this event was in retrospect referred to as 'carnage by computer'. This mass slaughter led to many knock-on social and economic affects and importantly this decision to dispose of this volume of animals was not subject to a veterinary assessment (Kitching, Thrusfield & Taylor, 2006). Keeling (2005) argues that using a two-way process is better to ground truth decision making in this type of event where the experts develop and formulate a verbal model developed from experience and knowledge check that the mathematical model and computer predictions agree with their understanding.

All three models used during the 2001 FMD response in the UK have continued to be substantially refined. Any future epidemics of Foot-and-Mouth Disease (or other livestock Diseases) in the UK or elsewhere will probably witness the use of a variety of models to help better inform policy decisions. The learnings from the 2001 FMD UK response has changed how these three modelling groups are managing how the models result in decision making. All three modelling groups are attempting to characterize a range of plausible epidemiological scenarios and responses where modelling approaches take into account logistical constraints and the trade-offs between strategies that may be caused by limited resources (Keeling, 2005).

The use of modelling for FMD response planning has been discussed above with the example of the 2001 UK FMD response. While the use of modelling during the UK Foot-and-Mouth Disease response has been the source of much criticism, what has become clear is that solely using a model during the event in real time to drive decision making has limitations. In particular the models were using during the 2001 UK FMD response to condone action such as culling practices which in retrospect lacked the *social licence* to do so. The limitations of the Disease models to make decisions have been highlighted, where models cannot replace

policy and the use of real life expertise. The dependence on models can therefore deflect attention from a larger more holistic dataset or information which can provide more balanced, social focused and real life feedback

FMD significance to New Zealand

New Zealand is uniquely vulnerable to Foot-and-Mouth Disease due to the nation's heavy reliance on exports of animal products. While the risk of an incursion is considered low, the impact would be severe (Forbes & van Halderen 2014). Where it is accepted there would be no community, family or industry untouched by the impacts of a large scale FMD outbreak in New Zealand. Therefore the spread of the virus in the period between virus introduction to New Zealand and detection of the first case is highly influential on the size and duration of the epidemic. In the event of an incursion New Zealand will be under intense scrutiny both nationally and internationally, and the success or failure of any response will determine the country's credibility and standing with its trading partners, the government and the New Zealand public (Clift, 2014).

The effect of an outbreak on the New Zealand economy would be catastrophic for the nation. The net present value (NPV) loss in real GDP over June 2012 to 2020 was estimated at $16.2bn for the large scale FMD scenario (Forbes, & van Halderen, 2014 p. 5).

The risk of a FMD outbreak in New Zealand is influenced by five main variables:

1. the risk status in overseas countries,
2. mechanisms of transferring the virus to New Zealand,
3. the efficacy of border protection,
4. the opportunities for initial viral contact with susceptible animals,
5. and the subsequent spread to secondary properties (Forbes, & van Halderen, 2014 p. 5).

While the risk might be low, the consequences of an outbreak occurring are likely to be very great to the economy. Sanson (1993) posited that the economic consequence was analogous to the issue of nuclear power safety. The 2013-2014 FMD Review undertaken by Forbes and van Halderan (2014) was based on four main stages to fully understand the potential economic cost of an FMD response in New Zealand. The four main analytical stages to this work were as follows:

1. Epidemiological models used to simulate the way FMD might spread throughout the country of New Zealand from an initial outbreak;
2. Scenarios selected from the epidemiological modelling to represent a range of potential Disease spread patterns across New Zealand;
3. Production models used to estimate the cash impacts on producers and export receipts under each scenario; and
4. A whole economy macroeconomic model was used to trace the ripple effects of these cash impacts through the New Zealand economy. (Forbes & van Halderen 2014 p. 4).

Three scenarios were selected from these 100 possibilities. There was only one infected property (IP) in the "small" scenario; 52 IPs in the medium scenario and 508 IPs in the large scenario (Forbes & van Halderen 2014 p. 4).

The use of the response modelling enabled a broad pattern of results which are considered reliable and accepted as likely that an outbreak of FMD in New Zealand would cause:

1. A large loss of national income with most of the impact falling on the primary sector and agricultural processors;
2. An increase in world prices for agricultural commodities;
3. A depreciation in New Zealand's exchange rate; and
4. Recovery timing (after eradication) that depends on our trading partners (Forbes & van Halderen 2014 p. 6).

While FMD has never occurred in New Zealand, there have been introductions of exotic Diseases which have occurred on a number of occasions including two outbreaks of hog cholera (classical swine fever) (Horner, 1984). The hog cholera outbreak occurred in Wellington (1930) and in Auckland (1953), and both cases were traced to the illegal feeding of uncooked ships garbage. On both occasions, eradication by slaughter was successful. Scrapie has also occurred twice in New Zealand (Horner, 1984). In 1952 the Disease was diagnosed in Suffolk sheep which had been imported from England two-and-a half years previously. The Disease was eradicated by slaughter of affected and in-contact sheep. A further importation of sheep from the United Kingdom in 1972 ended in the slaughter of all the imported sheep and their progeny after the diagnosis of Scrapie in 1978. Other examples of the introduction of viral Diseases which have subsequently persisted in this country

include Aujeszky's Disease (Burgess et al., 1976; cited in Sanson 1993), enzootic bovine leucosis commonly known as Bovine leukemia virus (Parrish et al., 1982; cited in Sanson 1993) an avirulent Newcastle Disease virus and caprine arthritis-encephalitis commonly known as Big Knee Disease (Oliver et al., 1982 cited in Sanson 1993;).

Australia has also recognised the severe impact that FMD would inflict on that country's economy. In the 2011 Australian report on biosecurity capability entitled *A Review of Australia's preparedness for the threat of Foot-and-Mouth Disease* the Australian biosecurity capability needs and the issues being experienced in building response preparedness capability is reported upon (Mathews, 2011). This Australian review sets out the issues being faced by Australia in the development of preparedness for an FMD incursion and the current state of their biosecurity preparedness. The resultant policy directions which have arisen from this report include:

a) Assertive and sustained Australian Government leadership
b) Focus more resources and effort towards the 'earlier' elements of the emergency management continuum
c) Institutionalising processes to ensure continuing refinements and strengthening of FMD preparedness and response arrangements into the future
d) More rigorous application of the risk-return principle, not only in border operations, but throughout the entire biosecurity continuum (Mathews, 2011).

This report by Matthews (2011) highlights areas of significance which include leadership, focus on resourcing needs, and attention to process and procedures. Since the report was published in 2011, Australia and New Zealand have agreed to work together to prepare for the unlikely event of a Foot-and-Mouth Disease (FMD) outbreak in either country. Australian Minister for Agriculture, Barnaby Joyce, and New Zealand Minister for Primary Industries, Nathan Guy, welcomed the signing of a Memorandum of Understanding (MoU) in 2014 to stress the importance of collaboration in combating the Disease and its devastating impacts. The objective of this cooperation is to keep FMD out of Australia and New Zealand and to achieve this both countries have agreed to work together. A benefit of the MoU is helping to ensure that an international reserve of veterinary specialists and other skilled personnel can be activated quickly in the event of an outbreak (MPI, 2014).

Use of Modelling for Biosecurity

Models are used to improve our understanding of the epidemiology of a Disease, both to explore how a situation may develop in response to different intervention and to contribute to risk management decisions. Models allow the potential size and economic impact of Disease incursion to be measured and quantified and to therefore evaluate the value or cost benefit of surveillance and control strategies. Models also provide the data to design incursion scenarios which can be utilised to test (exercise) a response system which can support policy development and aid communication to justify spending (Bingham, 2014; Gupta, 2001; Gill, 1993).

The risks of depending on models include a lack of understanding of the limitations of a model, and the danger of a model being fundamentally flawed. Also the perception of a model as a certain predictor of certainty is dangerous where numbers and charts can appear deceptively certain, where it is really only a guess aided by the parameters of its design (Bingham, 2014; Graat & Frankena, 1997).

Due to the difficulties associated with the validation of data outputted from modelling, these are best used in the following preparedness activities:

1. Training and exercises,
2. Contingency planning:
3. Detailing the merits of various control strategies,
4. Retrospective analyses of past outbreaks,
5. Surveillance activity targeting and
6. Response resource planning (Bingham, 2014; Graat & Frankena,1997).

There is no agreed classification system for models. The types of models used for biosecurity are presented in Table 1 below, these include; risk models, analytical models, population models, and economic models, specialised and epidemiological models. Risk models quantify the risk of introduction of an unwanted organism through routes. These routes are termed risk pathways and they help understand how a Disease or organism is transmitted from one geographic area to the next and also identify potential vectors which can transport the Disease. Analytical models seek to establish associations between occurrence of Disease and risk factors; these help site the level of probability of the incidence of the Disease. Disease models demonstrate the spread of Disease in a population and therefore population

models exhibit the dynamics of a population. Economic models look at production and using resourcing translate this into economic values. With specialised model specific information such as climate and air flow can be used to understand the airborne spread of Disease agents which help inform and guide decision making in a biosecurity response (Bingham 2014). An epidemiological model in particular is a mathematical and or logical representation of the epidemiology of Disease, it is a tool that can provide insight into Disease management through accumulation of what is known about a Disease and enables the development of educated guess or scenarios about what might happen in future situations (Gupta, 2001; Gill, 1993).

Table 1: Types of Models Used in Biosecurity

Types of Model	**Characteristics and Use**
Risk models	Quantify the risk of introduction of an unwanted organism through routes Understand how a Disease or organism is transmitted for
Analytical models	Seek to establish associations between occurrence of Disease and risk factors; Estimate the probability of the incidence of the Disease
Population/Disease models	Model the spread of Disease in a population Model dynamics of a population
Economic models	Production and the use of resources Economic values
Specialised models	Model specifics e.g. airborne spread of Disease agents Inform and guide decision making
Epidemiological models	Insight into Disease management Enables the development of educated guess or scenarios

Therefore when presented with the results from a model, decision makers need to understand that the range of outcomes predicted by a model are directly influenced by the variables introduced into the model which can be limited, therefore limiting the ability of the model where there will undoubtedly be insufficient precision in knowledge (Den Ouden as cited by Graat & Frankena, 1997). This resultant variance implies that models cannot provide complete and unequivocal answers to a decision making problem. Decision makers require therefore require model results combined with other quantitative and qualitative criteria to guide decisions (Haywood & Haywood, 2002). Haywood and Haywood (2002) posits that while modelling can seem to be purely objective as an activity, there is a level of subjectivity inherent in each model; therefore that every model is affected by the world view of the modeller is important to be understood and acknowledged. Graat and Frankena (1997) also

observed that a single model may not be able to answer all questions because it inherently has a specific goal.

Bingham (2014) argued that while all models are wrong, some are useful when used as an approximation of real life and they do not replace the need for proper data collection and analysis (Bingham, 2014 p. 3). Models are advisably used as one tool amongst others to help with Disease management; other tools include common sense and experience. In addition, international cooperation is important in developing and validating models. This is vital to ensure they reflect scenarios as accurately as possible (Kitching, Thrusfield & Taylor, 2006). Additionally, models generated to assist in the control of a specific epidemic are tactical rather than strategic, which further limits their effectiveness (Holling, 1966; cited in Bingham 2014).

The most appropriate use of models is as inter-epidemic tools, used in between events to aid retrospective analysis of real epidemics, to gain an understanding of their behaviour. Hypothetical scenarios can then be modelled to develop insights into the relative merits of different strategies in different situations. In this way, decision-makers can be provided with a priori of supporting guidelines, used in conjunction with veterinary wisdom and experience, not as a substitute for them (Kitching, Thrusfield & Taylor, 2006). One of the most important advancements for the future would be to combine the expertise of modellers, veterinarians and those responsible for implementing policy (Eddy, 2001; cited in Keeling 2005).

FMD Operational Resource Capability Modelling

The following section looks in particular at the history of FMD biosecurity Operational Resource Calculator modelling. The modelling of biosecurity incursions and the intent of the Operational Resource Calculator Model was introduced by the Ministry of Primary Industries as a result of an OAG report to help identify the different capability and skills requirements to manage specific responses, starting with foot-and-Mouth Disease (MAF, 2011).

This Operational Resource Calculator has been used to develop a framework for determining the capacity requirements and recruitment priorities to grow the NBCN to meet these operational response requirements. The calculator enables the level of readiness of the NBCN to be calculated and quantified in relation to a potential FMD response. This enabled the targeted prioritisation of recruitment (AsureQuality, 2013s),

The 2011 FMD model was developed in response to the MPI report 'Assessing New Zealand's preparedness for incursions of Foot-and-Mouth Disease and recommendations for improvement' by the Combined Government and Industries FMD Preparedness Working Group (FMG) Final Report, October 2011 (MAF, 2011). This report requested that the NBCN capability be benchmarked to measure its ability to respond to an FMD response. At this time the scenario used was the most recent version (2011) of the New Zealand Standard FMD Model (NZSM), parameterized on the spatial and stochastic modelling platform InterSpreadPlus. From this epidemiological model the peak week was used to develop resource numbers for an Operational Resource Calculator which can measure NBCN capability. An operational resource calculator sets out the people and equipment required to respond to the movement of an organism. This ability to measure the NBCN capability for an FMD response has served as a strategic monitor of NBCN capability growth, and significant operational resource capability gaps. As a result, since the 4th quarter of the 2011/12 financial year the NBCN has been measured and benchmarked against the resource capability calculator developed from this 2011 FMD Scenario Model (AsureQuality, 2014h).

The biosecurity Operational Resource Calculator modelling uses a response scenario and models the numbers and types of roles required for operations based on the magnitude and scale of the response. The information provides the basis to plan for and pre-build suitable capability to develop an effective, ready and scaled biosecurity response for field operations. Through this work of modelling, the resulting resource calculator has the detailed information which enables the recruitment of companies or organisations into the National Biosecurity Capability Network (NBCN) to utilise this capability in the event of an incursion. In terms of measuring levels of capability the Operational Resource Calculator enables capability to be measured against 100 per cent of the scenario. Over time the use of benchmarking has become more important to allow capability above 100 per cent to be communicated in relation to the scenario (Murray 2011). Bench marking is important to establish measures

and targets which are tools in project management and research and development (Coombs, McMeekin, & Pybus, 1998).

The FMD scenario and resulting Operational Resource Calculator model was developed over two phases, the first phase was in 2011 when the original model was developed and the second phase was in 2014 when this model was updated for the MPI FMD preparedness programme. The FMD incursion scenario sets out the practical implications of a FMD incursion in New Zealand, detailing the distribution of the Disease from positive diagnosis onwards over time. Included in this scenario are the number of animals affected, the time for the spread of the virus and resultant geographic spread of the Disease. The scenario developed for FMD is based on a scenario in the 75th percentile range, which is a large scale FMD incursion. Taking this FMD scenario information the resources required by response field operations to manage a response of this scale in the four response work stream areas of Surveillance, Organism Management, Movement Control and Logistics was set out. The information from this scenario provided a set of roles with the numbers and capability of people required. This FMD Operational Resource Calculator model enables the identification of the types and volume of capability required to respond to an incursion in the 75th percentile range (Murray, 2011). There are currently five sets of models measuring NBCN response capability. The FMD, Forestry Horticulture, Marine and Environmental Operational Resource Calculators were reviewed against generic operational and logistical response requirements and amended accordingly. In addition, the FMD model has been updated to reflect the 2014 FMD model currently being used for the MPI FMD preparedness programme (AsureQuality, 2014a).

The current (2014) MPI FMD Preparedness Programme has utilised a different FMD scenario, this has resulted in a need to align the NBCN operational capability being built with the work being undertaken to build and measure FMD preparedness. In the first quarter of 2014/15 the 2011 model was reviewed and adjusted to reflect the 2014 model based on the number of IP's (infected places) in the peak week. The Operational Resource Calculator developed, entitled the 2014 FMD Model, will act as an interim measure for NBCN capability until the MPI FMD Preparedness Programme work has been completed and the addition of new roles and people requirements can be fully understood. It is anticipated that at this juncture a more detailed, final version of an FMD Operational Resource Calculator will be developed. The Operational Resource Calculator Model that has been accessed in this

case study is the original resource calculator which has been in place from 2011 to 2014. Further iterations of the Operational Resource Calculator support the pretext to explore the significant, efficacy and use in this tool's contribution to biosecurity preparedness (AsureQuality, 2014d).

What is not clear is whether having a benchmark developed from a scenario and modelling process enables a realistic albeit qualified target to be established for the recruitment and development of an effective biosecurity operational response capability (Murray, 2011; Coombs, McMeekin & Pybus, 1998). This is an important question for the profession; what is the role and the significance, if any, of undertaking incursion modelling and scenario development to aid better biosecurity response operations preparedness?

To answer the above question, this research looks at understanding the role and the significance of undertaking incursion modelling and scenario development designed to aid better biosecurity response field operations preparedness. The use of modelling techniques, from a number of incursions, will be profiled drawing on the work of authors such as Arun, Elias, Robert, Cavana and Lurie, Jackson (2011) and Coager (2011) for different biosecurity incursions. Various agencies such as SCION (2009) and Biosecurity New Zealand (2008) have provided important background information about biosecurity incursions. This literature profiles the risks and the implications of incursions to New Zealand. Reports from the AsureQuality Biosecurity Response Services contract from 2011 to 2014 will be utilised to profile the use of the Operational Resource Calculator for FMD preparedness as a case study.

Chapter 3 Research Methodology

Introduction

Chapter 3 outlines the research methodology utilised for this research dissertation. This section will set out the research question, type of research methodology chosen and the methods of data collection employed for this dissertation.

Research Question

The research question for this work is 'How has Operational Resource Calculator incursion modelling' contributed to building biosecurity preparedness in New Zealand: A case study of the use of a Foot-and-Mouth Disease Operational Resource Calculator model between 2011 and 2014. This dissertation aims to review the usage and efficacy of the Operational Resource Calculator modelling and scenario process and explore the role it fulfils in the aim to build greater capability and readiness for a biosecurity response in New Zealand.

There are subsequent sub questions which originate from the main research question as follows:

a. Where does Operational Resource Calculator modelling fit in biosecurity preparedness?

b. Does Operational Resource Calculator modelling have a role in other emergency preparedness areas?

c. How has operational resource modelling contributed to preparedness for biosecurity?

d. What are the learnings from the emergency events which have occurred in New Zealand around emergency preparedness?

e. How can mainstream emergency management learnings be integrated into the biosecurity preparedness space?

f. What are the recommendations for future use of the Operational Resource Calculator

Aim of the research

To answer the research question, the research aims to:

- Document the role of Operational Resource Calculator incursion modelling in the context of developing biosecurity preparedness.
- Explore the relevance or the efficacy of the scenario and modelling process through benchmarking the requirements for biosecurity preparedness
- Document how the themes of the preparedness, introduced from emergency events which have occurred in New Zealand relate to biosecurity emergency preparedness

Qualitative Research

Creswell (1994) defines a qualitative study as an inquiry process of understanding a social or human problem, based on building a complex, holistic picture, formed with words, reporting detailed views of informants and conducted in a natural setting (Creswell, 1994 p.2). Qualitative research methods are utilised to gather an in-depth understanding of human behaviour or a phenomenon and the reasons that govern that behaviour or position. The qualitative method investigates the why and how of decision making, not just what, where, when which is measured in Quantitative research methodologies. Due to the in-depth nature of the investigation in Qualitative research a focused sample size of data is more often used than large samples (Denzin & Lincoln, 2005).

The qualitative case study methodology provides the researcher with tools to study complex phenomena within their contexts. The qualitative case study is an approach to research that facilitates exploration of a phenomenon within its context using a variety of data sources and types of data according to Baxter and Jack (2008). Due to the research question which asked how has the use of the Operational Resource Calculator contributed to biosecurity response preparedness between 2011 and 2014, this is considered or can be defined as the phenomenon. The area of developing and building biosecurity preparedness is complex, it requires a number of different approaches and concepts to be balanced and therefore the study or examination of this area lends itself to the case study and qualitative methodology techniques.

The research methods chosen for this dissertation have employed qualitative research methods in the form of a case study of the Biosecurity Response Services contract over a three year period, from 2011 to 2014 and a review of the literature from three New Zealand Emergency Events in the past give year; the Christchurch Earthquakes 2011 and 2012, and The Pike River Coal Mine Tragedy 2010; the PSA Kiwifruit Response. The case study has used the literature generated from the Biosecurity Response Services contract from the 2011 to 2014 period. This data, utilised for this study is primary in the form of published reports.

According to Yin (2003) a case study should be considered when: (a) the focus of the study is to answer "how" and "why" questions; (b) you cannot manipulate the behaviour of those involved in the study; (c) you want to cover contextual conditions because you believe they are relevant to the phenomenon under study; or (d) the boundaries are not clear between the phenomenon and context (Yin, 2003 p.23). The research question for this dissertation is "How has the use of Operational Resource Calculator model aided better biosecurity response preparedness" which agrees with points a, b, c and d from Yin (2003) above.

Due to the breadth of the data and material which is involved in the Biosecurity Response Services contract from 2011 to 2014, the use of a case study is the only method which allows a robust and comprehensive examination of this literature. This desk based research method has been chosen due to the breadth of reports and documentation available for this case study. The review of the contract documents will enable a detailed profile to be developed without the need for additional data collection through interviews or focus groups. The case study research method is defined as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used" (Yin, 1984, p. 23). In this case study, the documentation will be sourced from a variety of different programme projects which have been implemented to increase biosecurity operational response preparedness. These projects vary in type from systems development, training, exercising and recruitment of organisations to the NBCN.

Case Study Strategy

The use of a case study is suitable type of tool to use when a holistic, in-depth investigation is required; using the prescribed processes and procedures for case studies, enables the research to be scientifically robust. While other methods of data collection are known to hide some

detail (Stake, 1995), case studies are designed to bring out the details (Tellis, 1997). In addition, case studies are the preferred method of research when 'how' or 'why' questions are being posed and when the researcher has little control over events and the focus is on a contemporary phenomenon within some real life context which include descriptive case studies (Yin, 2003).

In the context of this research, the research question is 'how has the use of incursion Operational Resource Calculator contributed to biosecurity response preparedness'. Therefore, there is no requirement for the need for control over the events from the period from 2011 to 2014 because the focus is on the contemporary events themselves within this period of the Biosecurity Response Services contract. Also the case study as a research strategy method 'allows the researcher to retain the holistic and meaningful characteristics of real-life events such as individual life cycles, organizational and managerial processes, neighbourhood change, and in the context of this case study the events which governed the management of the Biosecurity Response Services contract (Yin, 1984 p.2).

According to Platt (1992) the choice to use a case study is not about an ideological commitment, but the logic of design and a preferred strategy, circumstances and the research problem. In this case the circumstance is the period of time over which Operational Resource Calculators have been used within the Biosecurity Response Services contract and the significance of this use to contributing to biosecurity response preparedness. The logic behind this case study methodology is to use the phenomenon of the Biosecurity Response Service Contract over 2011-14 and review this for key themes which have come out of this period (Yin, 2003). These thematic areas will be reviewed and analysed, looking at how preparedness in these areas relate and are affected by the development of the Operational Resource Calculator developed for FMD (Patton, 1990).

Development of the Case Study

The development of this case study research methodology approach has relied on the approach taken by a number of academic leaders in this field of research including Stake (1995), Simons (1980) and Yin (2003). The first part of the process is to determine and define the research question; following this stage the data gathering was undertaken. For this case study the data was sourced from the Biosecurity Response Services contract reports from 2011-2014. The analysis technique that was used is thematic coding, this is defined as

the use of a dataset, in this case documents, to establish what codes exist in the literature. For the purpose of this work where the preparation and data collection was undertaken utilising the files from the contract over the agreed period stated above. The resultant evaluation of the results employed the key preparedness themes introduced from the three New Zealand Emergency Events over the past five years, the Pike River Mine Disaster 2010, The 2011 Christchurch Earthquake and the PSA Kiwifruit Biosecurity Response 2010, reviewed in Chapter 4 (Stake 1995, Simons 1980, Yin 2003). The findings will be of value to AsureQuality and MPI as well as the New Zealand economy to identify if there are areas within biosecurity response preparedness which can be improved for future responses.

The process stages described above can be summarised as follows:

- Determine and define the research questions
- Select the case and determine data gathering and analysis techniques
- Prepare to collect the data
- Collect data in the field
- Evaluate and analyse the data
- Prepare the report (Stake, 1995; Simons, 1980; Yin, 2003)

There are three important principles of case study data collection methods which should be followed. These are to ensure there is multiple data sources utilised, create a case study database of the material collected and maintain a chain of evidence to address reliability of the information in the case study. For this case study documentation sources were utilised with corroboration from secondary documentation sources (Yin, 1994).

Primary and Secondary Data

Both primary and secondary documents are analysed but primary literature provides the main source of data for the case study. The sources of information can generally be categorised as primary, secondary or tertiary depending on their originality and their proximity to the source or origin (James Cook University, 2012). Primary literature sources of data are a first-hand account of events as they unfold. Primary data for this research project was sourced from a variety of project reports, project plans, meeting minutes and reviews undertaken by the project team members (Creswell, 2008).

Primary Data Sources

The primary data which was collected for this case study was extrapolated from contract reports and project documents. These documents are intended to provide a robust and complete picture for the case study where the project reports and supporting documentation provide an objective account of the use of the FMD Operational Resource Calculator according to Yin (2003). While this is the case, the researcher will remain cognisant of the risk that any data set can lack objectivity and be layered with subjectivity and opinion bearing in mind that every document has a specific purpose and audience other than those of the case study being undertaken (Yin, 2003).

There are a number of pros and cons of using documentation for case study data. The advantages being that this information is stable and can be reviewed repeatedly, it is also unobtrusive and its creation is not due to the case study itself, giving it objectivity. The documentation is accurate, where it is a document the status of the project at the time, it also covers a period of time which according to Yin (2003) supports using this data source for case studies. The disadvantages of this source of data are the level of retrievability, the writer's bias and selectivity if the collection is incomplete due to blocked sources (Yin, 2003). These disadvantages have been negated due to the full complement of documentation from the 2011-2014 period of the Biosecurity Response Services contract being available In addition, the bias of the writer of the material will be addressed by cross checking key concepts and findings to ensure they are corroborated from other sources and substantiated (Yin, 2003).

As stated above the primary data was collected in the form of project reports which were sourced from both the project team and consultants employed to implement the FMD Operational Resource Calculator modelling and scenario work developed between June 2011 and December 2011. The types of documents included Project Deliverable Reports, Project Close Out Reports and project presentations from the respective projects within the Biosecurity Response Services contract programme of work from 2011 to 2014. These reports document the aims, objectives and outcomes of each project and also the programme outcomes from each year. In addition, quarterly contract reports communicate the level of preparedness based on the Operational Resource Calculator models developed; all of these reports are submitted to the Ministry of Primary Industries (MPI) as part of the contractual

obligations of the Biosecurity Response Services contract. These project documents were the core documents used for the development of the case study.

Secondary Data Sources

Secondary documents are documents which are linked in some way to this topic and which provide secondary analysis of the data found in the primary records (Gosling & Edwards, 1995). Secondary literature will document, through other project reports, how decision making was determined or affected by the modelling and scenario process. Secondary data will provide proxy data which will be used for the analysis of the primary data and the generation of recommendations. The disadvantages with secondary data are acknowledged; these weaknesses include but are not limited to, the lack of consistency of perspective, biases and inaccuracies which cannot be checked. In addition, published reports can often raise more questions than they answer (Gosling & Edwards, 1995). While there are disadvantages in using secondary data, these are somewhat negated in this context by searching other project related reports which are linked to the overall Biosecurity Response Services contract. These documents provide a continuity of recording the results achieved from the use of the Operational Resource Calculator and can therefore support more detailed analysis (Gosling & Edwards, 1995). Also the author's professional position and 'lens' can be used to assess the efficacy of the data gathered and the value or otherwise of the secondary literature.

Data Analysis

The analysis of the data contained in the project documents will require the researcher to elucidate how the Operational Resource Calculator modelling work has supported AsureQuality's Biosecurity Business Unit's and the Ministry for Primary Industries' (MPI) ability to increase preparedness for a biosecurity incursion. The specific type of data analysis chosen for this case study is Thematic Analysis; this is a process of encoding qualitative information according to Boyatzis (1998). This method of data analysis was chosen to get close to the data and develop some deeper appreciation of the content and one of the benefits of thematic analysis is its flexibility (Braun & Clarke, 2006). This method is useful when the intention is to unearth the themes salient in a text at different levels (Attride-Stirling, (2001). Therefore, thematic analysis helps researchers move their analysis from a broad reading of the data towards discovering patterns and developing themes (Boyatzis, 1998). For the purpose of this case study, this method will be used to identify the themes from the material

and to work out how these themes relate to each other within the data set (Gibson, 2006). These themes can be seen as creating 'bundles' of instances in the documentation.

Thematic Analysis

Thematic analysis was utilised to analyse primary and secondary data, where it focused on examining themes within that data. Thematic analysis is discursive and elucidates the main categories in the texts which emerge rather than these being predetermined. Because the themes develop from the text the researcher is able to be descriptive, therefore this process lends itself to qualitative research methodologies. It is considered that thematic analysis is the most useful method in capturing the intricacies of meaning within a qualitative data set (Guest, 2012).

Other types of analysis were considered for this methodology, in particular that of Content Analysis. Thematic Analysis was chosen instead of Content Analysis because the former, through focusing purely upon meaning, promotes a more discursive interpretation since individual codes can cross-reference multiple themes (Braun & Clarke, 2006). Content Analysis employs predefined mutually exclusive categories to count the frequency of a theme and is more appropriately used to statistically test any hypotheses and resultantly does not lend itself to the qualitative research methods and principles (Bowers & Courtright, 1984). Therefore, in choosing Thematic Analysis the themes are not predetermined but will emerge from the texts enabling the researcher to be more descriptive and deductive in the analysis and development of recommendations.

Thematic Analysis Process

The process for Thematic Analysis has relied on Braun and Clarke's (2006) process as follows:

- The generation of themes
- Creation of sub-topics
- Identification of similarities and contradictions, compare and contrast
- Results are written up and conclusions deducted (Braun & Clarke, 2006 p.19).

A theme captures something important about the data in relation to the research question, and represents some level of *patterned* response or meaning within the data set. An

important question to address in terms of coding is what counts as a pattern/theme, or what 'size' does a theme need to be? (Braun & Clarke, 2006; Clarke & Kitzinger, 2004). The 'keyness' of a theme is not necessarily dependent on quantifiable measures but in terms of whether it captures something important in relation to the overall research question. (Braun & Clarke, 2006)

Thematic Analysis methods typically focus on exclusively or primarily on one level, focusing on what is explicit in the documentation and the content of the primary data set (Boyatzis, 1998). Once the themes are identified, sub-topics, similarities and contradictions are then considered and quotes selected that encapsulate each category. The results of this categorisation are written up and conclusions deduced (Patton, 1990: Patton, 1980).

Theme Generation

The process for the generation of themes starts with the primary data which is analysed. The information is outlined in a logical and chronological order and analysed for relevant themes. The raw data is then placed into a common format and read thoroughly for familiarisation. The emerging dominant and consistent themes are segmented into units and these units are then categorized. Each unit is counted as a member of a category that is practically or theoretically interesting to the researcher as being useful (Bowers & Courtright, 1984). Braun and Clarke (2006) developed six phases of thematic research which are relevant for this study and which are presented in Table 2. Braun and Clarke's (2006) methodology process was chosen for this study due to the detailed process for data collection and analysis which is deemed particularly appropriate for this topic.

Table 2 Phases of Thematic Analysis

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Phase	Process	Result
Phase 1	Read and re-read data in order to become familiar with what the data entails, paying specific attention to patterns that occur.	Preliminary "start" codes, detailed notes, and documentation of the process in reflexivity journal.
Phase 2	Generate the initial codes by documenting where and how patterns occur. This happens through data reduction where the researcher collapses data into labels in order to create categories for more efficient analysis. Data complication is also completed here. This involves the researcher making inferences about what the codes mean.	Comprehensive codes and a reflexivity journal that states how and why codes were formed.
Phase 3	Combine codes into over-arching themes that accurately depict the data. It is important in developing themes that the researcher describes exactly what the themes mean, even if the theme does not seem to "fit." The researcher should also describe what is missing from the analysis.	List of candidate themes for further analysis. Reflexivity journals need to note how the codes were interpreted and combined to form themes.
Phase 4	In this stage, the researcher looks at how the themes support the data and the overarching theoretical perspective. If the analysis seems incomplete, the researcher needs to go back and find what is missing.	Coherent recognition of how themes are patterned to tell an accurate story about the data.
Phase 5	The researcher needs to define what each theme is, which aspects of data are being captured, and what is interesting about the themes.	A comprehensive analysis of what the themes contribute to understanding the data.
Phase 6	When the researchers write the report, they must decide which themes make meaningful contributions to understanding what is going on within the data. Researchers should also conduct "member checking." This is where the researchers go back to the sample at hand to see if their description is an accurate representation.	A description of the results.

(Braun & Clarke, 2006, p.93)

The categories or themes in phase 3 above were constructed after the information was gathered and studied rather than setting the themes before the study and adapting the information to fit. The various categories are evaluated from the text and then the text sorted into units that were allocated to the categories. Some units or segments of text can be allocated into more than one category and some text not assigned to any category.

In terms of verifying the categories, an independent researcher (or colleague) for example, was given a copy of the research objectives and examples of the raw text and asked to develop categories from the text (Thomas, 2003). In following this method, the categories

can both be tested for their validity and also reviewed if required. The analysis of the case study documents was undertaken by the researcher, Deirdre Nagle.

Conclusion

This chapter has outlined the research methodology employed for this research dissertation. The choice of a Qualitative research methodology was justified due to the need to understand the why and how as well as the what. The justification for a case study was less related to an ideological perspective and more to cover a period of the Biosecurity Response Services contract from 2011-14 and understand the preparedness themes which are related to the use of the Operational Resource Calculator. The Thematic Analysis method was employed to elucidate the themes due to the opportunity this method allows for the themes develop out of the literature as opposed to predetermined theme generation. The following chapter, chapter 4, presents the results from the Biosecurity Response Services contract 2011-14 and the three New Zealand Emergency Events in the past five years; the Christchurch Earthquakes 2011 and 2012, and The Pike River Coal Mine Tragedy 2010; the PSA Kiwifruit Response.

Chapter 4 Results

Introduction

This chapter presents two sets of results, the results from the Biosecurity Response Services contract 2011-14 and the three New Zealand Emergency Events in the past five years; the Christchurch Earthquakes 2011 and 2012, and The Pike River Coal Mine Tragedy 2010; the PSA Kiwifruit Response 2010.

Review of three New Zealand Emergency Events in New Zealand in the past five years

The following section presents the lessons learnt and recommendations that are particularly relevant to biosecurity operational response from three New Zealand Emergency Events in the past five years; the Christchurch Earthquakes 2011 and 2012, and The Pike River Coal Mine Tragedy 2010; the PSA Kiwifruit Response Assessment Report, MAF, 13 October 2011 (MAF, 2011) to extract the common themes from these events which relate to response preparedness.

Due to the breadth of these events this section will summarise the recommendations and learnings from the 2012 Royal Commission Report on the Pike River Mine Tragedy in 2011 (Royal Commission, 2012), the Christchurch Earthquake Commission's Report (MCDEM, 2012) and the PSA Kiwifruit Response Assessment Report, MAF, 13 October 2011 (MAF, 2011).

Pike River Coal Mine Tragedy, 19 November 2010

There are a series of recommendations made from the 2011 Royal Commission Report on the Pike River Mine Tragedy; the recommendations which will be profiled in this section are those which focus on emergency preparedness. Recommendation 13: "Emergency management in underground coal mines needs urgent attention", and Recommendation 14: "The implementation of the co-ordinated incident management system (CIMS) in underground coal mine emergencies should be reviewed urgently", are profiled in this review due to their direct relevance to the area of response preparedness (Royal Commission, 2012, p.39). Recommendations 13 and 14 from the Royal Commission report of the Pike River Coal Mine tragedy found that emergency management, in underground coal mines, needs urgent attention, and that the implementation of the co-ordinated incident management

system (CIMS) in underground coal mine emergencies should be reviewed urgently. This recommendation to implement the CIMs system highlights the need to use an emergency management structure which aids integration of agencies, collaboration and negates conflict at the time of a response (Royal Commission, 2012).

Emergency Plans

Recommendation 13 covered the need for legislation to include the need for a comprehensive emergency management plan which is regularly audited and tested by the mine company itself and by the government regulator from the Department of Labour. The report sets out in recommendation 13 that this planning should be developed in conjunction with the mine workers and the Mine Rescue Service where the facilities within the mine such as the location of refuges, change-over stations and emergency exits should be specified. These plans should have thought through the approach to contacting next of kin and fielding enquiries from genuine people providing them with appropriate communication. In addition a list of emergency contact details for all workers should have been kept up to date at all times. Any Emergency Management plan developed for the mine plan should be compatible with CIMS, the co-ordinated incident management system used by New Zealand's emergency services and the Police (Royal Commission, 2012).

Coordinated Incident Management Systems

Recommendation 14 focused on the implementation of the co-ordinated incident management system (CIMS) in underground coal mine emergencies and further recommended that this system should be reviewed with urgency. The reason for the inclusion of this recommendation was to ensure that emergencies in underground coal mines are well managed in the future. In order to enable this, it was recommended that the CIMS framework should be rigorously tested by regular practical exercises at underground coal mines. In addition, the incident controller at an underground coal mine emergency must have mining expertise and, together with the incident management team, must be responsible for co-ordinating the emergency effort and approving key decisions (Royal Commission, 2012).

Both recommendations related to the need for better emergency planning prior to an event and the use of a coordinated incident management system (CIMS) require a focus on emergency preparedness, and understanding of the scope and scale of potential responses and

the resources required to respond effectively. These recommendations highlight the importance of structure, command and control mechanisms and a system to support multiple agencies to work together harmoniously in a large scale event. These elements of response management are similarly significant and required for biosecurity response management and as themes will be compared against the BRS Contract 2011-2014 in the results section.

Christchurch Earthquake, 22 February 2011

Following the report on the Christchurch Earthquake 2011, the Earthquake Commission presented a number of recommendations around training, exercising and the use of CIMS, infrastructure and logistics and the management of response capability community and volunteers which are relevant to building response preparedness for a biosecurity response. The following sections review these recommendations.

Training, Exercising and CIMS

There were ten recommendations around training, exercising and the improvement of the use of Coordinated Incident Management System (CIMS). CIMS was first developed in 1998 to provide emergency management agencies with a framework so they can coordinate and cooperate effectively in a response (ODESC, (2014). The major recommendation related to the need for a cadre of highly trained emergency managers from organisations across the country to be established to lead and control emergency responses. This would create a group of highly trained men and women who were competent and able to control and lead emergency operations centres (EOCs) in moderate and large emergencies at the start of any event. It was recommended that in particular during the response phase, only those with CIMS training and acknowledged as effective operational leaders be appointed to senior positions in a CIMS structure and that authorities ensure that only people who have completed the required training, and are suitable for the role, are placed in CIMS functional positions. In addition, for significantly large events an 'All of Government' approach should be taken to the staffing of the National Crisis Management Centre, drawing from those with skills and capability from across all government departments and agencies (MCDEM, 2012).

A focus on regular exercises was noted in several recommendations, stating that exercising is required for all levels including senior managers, to maintain operational readiness. A nationally consistent training of the Lifelines Utility Coordination Group (LUCs) should be

undertaken and exercise regularly both nationally and locally in a meaningful way (MCDEM, 2012).

Infrastructure and logistical preparedness

Logistical preparedness was identified in the Christchurch Earthquake Report as a priority where Emergency Operations Centres of whatever size, need to have the capability to become operational with minimal infrastructure in the first instance and not be location dependant. The responsibility for logistics between the National Crisis Management Centre and other government departments should be clarified and the respective roles planned and exercised enabling a more cohesive 'All of Government' approach (MCDEM, 2012).

Using external expertise from commercial logistics companies should be enabled to better support Civil Defence operational Centres with their sudden operational needs and activities. In addition the development of protocols to deal with abnormal payments needing urgent decisions in an emergency situation should be in place before an event (MCDEM, 2012).

Identification and Management of Response Capability, including Community and volunteers

The management of external assistance noted above was further stated in recommendation 93, 31 and 32. Firstly, a national resource database should be established listing providers of essential goods and services complete with at least three emergency contact points in each organisation. Secondly, better management of the exchange of personnel with emergency management agencies in Australia and within other New Zealand government departments such as the New Zealand Defence Force needs to be clarified. In addition, the management of unwanted or onerous support should be declined to prevent resources being misdirected from the response effort (MCDEM, 2012).

Managing and facilitating community participation and self-efficacy was acknowledged in several recommendations. This recommendation requires putting practical systems in place; for example a template to enable community organisations to link to the official response. In addition, it was identified that an Emergency Operating Centre should include, in its organisational structure, a single liaison point through which semi-spontaneous volunteer groups, that have strong self-management capability, can be tasked. This additional role will

require inclusion in the new CIMS 2 structure to enable community and voluntary organisations to plug into the official response, in a meaningful way (MCDEM 2012).

The themes from the Christchurch Earthquake Report which related directly to biosecurity preparedness include people capability, training and exercising, and understanding the resourcing needs and systems required to manage and deploy this capability. Because biosecurity preparedness is dependent on expertise and technical resources, the effective management of large groups of people is important. These themes will be explored in the case study analysis section in more detail.

PSA Kiwifruit Response, November 2010

The Ministry for Primary Industries, formerly MAF, published a Response Assessment Report following the bacterial kiwifruit vine Disease the PSA Kiwifruit Response Assessment Report, MAF, 13 October 2011 (MAF, 2011). This report identified that a number of areas of improvement could have supported a better operational response performance. These areas of improvement were the need for more industry specific planning, the development of response plans, a better response system knowledge and improved operational communication and resource management. These areas will be discussed in the following section because they relate to response preparedness and demonstrate areas within preparedness which can be transferred to biosecurity response management.

Industry Specific Planning

Recommendation one stated that industry-specific planning for likely outbreaks or incursions would have minimised grower/industry shock and maximised whole-of-system preparedness. Better understanding from the industry and growers prior to the event would have reduced relationship impact issues and helped cooperation during the response itself. An in-depth understanding of response roles prior to the response would have reduced confusion, particularly with line management roles (MAF, 2011).

Response Planning

The response Assessment Report 2011 which reviewed the learnings from the PSA response MAF (2011) acknowledged that had there been better response plans in place this would have aided better response management, especially on the onset of the PSA response. The resultant action coming out of this Assessment Report 2011 for the Ministry is to develop agreed and flexible response plans to execute strategy. If these plans had been in place this would have enabled a more considered, focussed and consistent response delivery across operational work streams. The existence of operational response plans would also allow testing and exercising prior to the event and build operational preparedness (MAF, 2011).

Response System knowledge

A recommendation which came out of the MAF 2011 Assessment Report from the PSA response was the need to increase the level of general preparedness which was directly related to the knowledge of the Response System itself. The report stated that had there been a higher knowledge of the Response System then this would have contributed to the achievement of realistic response objectives. If the Ministry personnel had better Response System knowledge then this in turn would have led to better more effective organisational and priority decision making required for this response. It is accepted that had better decision making been in place this would have resulted in better management both of the response and business-as-usual for the Ministry for Primary Industries (MAF, 2011).

Operational Communication and resource management

The recommendations from the Assessment Report 2011 which focused on operational communication and resource management suggest that this was an important facet of response operations which could have been improved. The lack of effective communication of information and resource transfer between individuals, teams, organisations and locations hampered operational response decision making. If mechanism were in place to coordinate resource management this would have enabled better decisions and actions by the most appropriate individuals or group for this response (MAF, 2011).

Key Preparedness Themes from the three New Zealand Emergency Events in the past five years

The key themes drawn from the three New Zealand Emergency Events in the past five years are as follows:

a) Leadership
b) Capability
c) Training
d) Exercising
e) Planning
f) Systems
g) Resource requirements
h) Information (AsureQuality, 2013v)

Biosecurity Response Services contract from 2011 - 2014 Case Study Results

This section presents the themes which have arisen from the Biosecurity Response Services contract from 2011 to 2014 since the introduction of the FMD biosecurity Operational Resource Calculator. The themes are presented below as they were found in the documents as per each financial year. While it was not anticipated that themes would necessarily be consistent over this period, this has transpired.

The Biosecurity Response Services contract file from 2011 to 2014 was reviewed following the process set out above in the Chapter 3 Methodology which describes the research design utilitsed for this case study. Initial start codes were developed, and from this point a list of candidate themes was developed for further analysis. Once the material was coded, interpreted and combined the final 5 themes were expounded and are presented in table 3 below. A summary of the codes, themes and sub themes is presented in Appendix a.

Table 3: Summary of Biosecurity Response Services Contract 2011-2014 Case Study Key Themes

Year	2011-12	2012-13	2013-14
Capability	Building the NBCN For Biosecurity Preparedness	Building the NBCN For Biosecurity Preparedness	Building the NBCN For Biosecurity Preparedness
Measuring Response Preparedness	Measuring Biosecurity Response Preparedness	Measuring Biosecurity Response Preparedness	Measuring Biosecurity Response Preparedness
Training/Testing/Exercising	Training Exercising and testing	Training Exercising and testing	Training Exercising and testing
FMD	FMD Response Preparedness	FMD Response Preparedness	FMD Response Preparedness
Relationships and leadership	Strong Contractor / MPI Relationships	Leadership and learning	Leadership and learning

Definition of Themes

The following section defines the themes which were extrapolated from the Biosecurity Response Services contract documents from 2011-2014. Each theme is presented with a short definition to aid understanding.

The theme definitions are as follows:

1. Building the NBCN for Biosecurity Preparedness

This theme is defined as the development of the National Biosecurity Capability Network to become New Zealand's field operations team for a biosecurity response. This involves developing capability for biosecurity response operations.

2. Measuring Biosecurity Response Preparedness

Measuring biosecurity response preparedness refers to the methods and tools used to measure, understand and report on the level of biosecurity operational response capability is captured by membership in the NBCN. This capability is measured using the FMD operational response calculator.

3. Training, Testing and Exercising

Training is the process of building capability to fulfill operational response management roles required. Testing is defined as measuring and reporting the NBCN capability against the Operational Resource Calculator and the ability to deploy the network quickly. Exercising is bringing the results from training and testing together to simulate a response and exercise people in response operations roles to test their capability.

4. FMD Preparedness

Foot-and-Mouth Disease (FMD) preparedness refers to building preparedness for operational activities in the field. This is the ability to undertake the tasks required of the five operational workstreams; Surveillance, Organism Management, Movement Control, Logistics and Operations Management.

5. Relationships and leadership

The Relationships referred to in this theme is defined by the Biosecurity Response Services contract agreement between with AsureQuality and the Ministry for Primary Industries. Leadership is taking the initiative and leading biosecurity response operations preparedness through the use and management of this relationship.

Presentation of themes

The themes from this case study are presented in the following section of this chapter. Each theme is presented in a discursive style.

Building the NBCN for Biosecurity Responses

The original biosecurity preparedness contract was the Field Operations Response Team (FORT) contract and from this came the Biosecurity Response Services Agreement which was signed in 2009. From this contract came the National Biosecurity Capability Network (NBCN) (AsureQuality, 2013v). Prior to the advent of the BRS Agreement in 2009, capability for biosecurity responses had been contracted on an annual, or as required basis, with limited knowledge available on capability outside of traditional suppliers. This approach was both expensive and administratively demanding for the Ministry for Agriculture and Forestry. This often required the management of multiple contracts and tender processes depleting resource available for strategy or high level execution during responses (AsureQuality, 2013v).

The National Biosecurity Capability Network (NBCN) became the new vehicle for delivering response capability in 2009. It was developed to facilitate access to capability where organisations are willing and able to commit resources in the event of a response. As the NBCN has grown since 2009, the capability has been leveraged through broadening the concept for the NBCN to include the supporting systems, processes, training, structures, and communications needed to deliver responses. The NBCN has become a key platform for biosecurity response preparedness (MAF, 2009; AsureQuality 2013b, AsureQuality 2013f; AsureQuality 2011b; AsureQuality 2011h; AsureQuality 2012j; AsureQuality 2012k). The vision for the NBCN is being achieved, to became ‘one team capable of dealing with any biosecurity emergency’ (MAF, 2009 p.2).

In the formal Biosecurity Response Services agreement signed in 2009 it stated that the NBCN will contain a range of organisations and capabilities for biosecurity response, which must be “real, effective, and deployable” (MAF, 2009 p.22). In order to ensure that resources are available when required, agreements with organisations with capability required for a biosecurity response to enter the NBCN were put into place and implemented. The NBCN

membership agreement commits organisations to provide a pre agreed organisational 'minimum capability' for the first seven days of a response if they are called upon (MAF, 2009 p.23). Minimum capability is defined as what resource an organisation could comfortably commit to the NBCN at its busiest period. Maximum capability is the total capability in the organisation which should a large response such as Foot-and-Mouth Disease occur would be made available to the NBCN (AsureQuality, 2012h).

The NBCN, is a network of people and non-people resources, which is sourced from AsureQuality, commercial New Zealand, Regional and Territorial Authorities and the Ministry for Primary Industries. These resources can be drawn on to deliver Biosecurity Responses of any envisioned size and duration to any unwanted organism. Whilst the planning for preparedness developed has been for generic responses the most exacting and economically significant potential biosecurity incursion response, FMD, has been central to initial years of building capability (AsureQuality, 2013t).

Developing the NBCN the strategy has been to have the right people with the right tools in the right place at the right time, building a coalition of willing organisations wanting to participate, while harnessing all resources available (MAF 2009; AsureQuality, 2012e). The concept of 'Best Capability' was developed, to describe the most suitable capability available to respond to any biosecurity emergency, ensuring effective and efficient biosecurity responses (MAF, 2009).

In the 2009 BRS agreement it stated the requirement that there will be an NBCN capability inventory developed to provide the infrastructure for the Capability Network. An inventory would have the following functions: record organisations, companies and other sources of capability for biosecurity response, including those in New Zealand and overseas, and commercial and non-commercial organisations; record capability used in responses; and facilitate analysis, retrieval and deployment of capability for biosecurity response, including monitoring of 'best' deployment of capability for responses (MAF, 2009). The result has been the development an information management system (IMS) developed in September 2012 based on the Ministry of Civil Defence and Emergency Management's version of E-Sponder, to support the management of the NBCN, and selection and deployment of resources for responses (AsureQuality, 2013f). Capability is documented in the NBCN IMS

which holds all the NBCN organisational details. During a response, capability in the NBCN can be found for deployment (AsureQuality, 2013f; AsureQuality 2014f).
Since the development of a biosecurity Operational Resource Calculator for FMD this provided a baseline to measure NBCN capability against (AsureQuality, 2014f). The resultant focus of recruitment has been to strengthen to the National Biosecurity Capability Network (NBCN) to respond to an FMD response. NBCN capability has grown from the end of the 2011/12 financial year from 10 per cent to 92 per cent at the end of the 2013/14 financial year measured against the Operational Resource Calculator (AsureQuality 2014f).

The areas with the largest known gaps in capacity and the highest risk to an animal biosecurity response can be identified using the Operational Resource Calculator (AQ, 2013). These are generally those areas requiring large numbers of personnel, or personnel with a specific skill or qualification that are likely to be in short supply. The recruitment plans developed have prioritised potential contributing organisations in order to identify those organisations that may fill the shortfall of capability and capacity in the most efficient manner possible (AsureQuality, 2012v; AsureQuality, 2012f).

The specific information around existing capability against the scenario model and the ability to identify specific gaps was used to:

a) Prioritise effort when building the NBCN
b) Determine gaps in available field resources
c) Develop alternative solutions to manage shortfalls
d) Understand & communicate capability & capacity of the NBCN (Murray, 2011c)

The NBCN Recruitment strategy over 2011/12/13 and 14 has been as follows:

- Target Recruitment to address capability gaps
- Build and inclusive network – MPI, All of government, Industry, Corporate
- Communicate to the Membership
- Build long term sustainable relationships (AsureQuality 2013r; AsureQuality2013s).

In addition to the areas of focus for building NBCN capability, usage of the Operational Resource Calculator has identified the need for an organisation with project management

expertise to manage the Organism Management workstream[6] for a large scale FMD response (AsureQuality, 2014g).

In 2013/14 an agreement was sought from the MPI/AQ Leadership Team[7] on what the NBCN would look like in five years' time. The options put forward for consideration were:

a) The same: the NBCN is maintained in its current state
b) Smaller / worse: the NBCN exists with fewer resources available, and/or resources that are less accessible
c) Bigger / better: the NBCN has more resources available, and/or they are more accessible
d) Doesn't exist: the NBCN no longer exists for one of the following reasons:
    1. Deliberate decision to close it down
    2. Exploded – the NBCN has a spectacular collapse
    3. Fades away – the NBCN withers and dies (AsureQuality, 2013v)

The reason this agreement was being sought was to impress upon the BRS Leadership Team the need to develop a clear vision for the growth and development of the NBCN until the end of the BRS Agreement in 2019. This was deemed important to ascertain a vision for the network to help ensure the current strategy employed in 2013/14 had a cumulative effect (Murray, 2013).

Measuring Response Preparedness – Scenario Modelling

Understanding the resource requirements for responses is fundamental to developing operational response capability. The development of an Operational Resource Calculator set out the people capability and numbers required to manage the operational activities for an FMD response in the 75 per cent range (Murray, 2011b). Building on this work, the additional resources required, plant and equipment, for a FMD response, were identified (AsureQuality, 2013d).

The development of the Operational Resource Calculator defined what capability and what level of operational capacity was required to manage an FMD response (Murray, 2011b). The

[6] The organism management workstream is responsible for destruction, disposal, valuation, security, cleaning and disinfection and health and safety, which is both resource and coordination intensive.

[7] This includes members from AsureQuality and MPI

FMD scenario and resultant Operational Resource Calculator was used as a benchmark to build the National Biosecurity Capability Network (AsureQuality 2012q; AsureQuality, 2012j; AsureQuality 2013s). This Operational Resource Calculator has been used to develop a framework for determining the capacity requirements and recruitment priorities to grow the NBCN to meet these operational response requirements. The calculator enables the level of readiness of the NBCN to be calculated and quantified in relation to a potential FMD response. This enabled the targeted prioritisation of recruitment (AsureQuality, 2013s), planning for annual preparedness activities and the ability to report on measurable progress on a quarterly basis to MPI (AsureQuality, 2013t).

Because the Operational Resource Calculator provides a quantifiable benchmark for biosecurity operational preparedness this enables detailed resourcing analysis to identify critical capability gaps to be addressed. The tool itself will not remain static and should review policy changes (AsureQuality, 2012q). For example, the MPI FMD Programme will require updates and further changes and iterations to the Operational Resource Calculator (AsureQuality, 2013s). This change ceases to be an issue because of the use of the calculator to inform decisions to increase the capacity of the NBCN to respond efficiently and effectively to a biosecurity emergency for an animal's response in the first instance (AsureQuality, 2014v).

Some areas of specific uses of the Operational Resource Calculator include providing direction for the Operational Response Stores Management Project over the 2013/14 year. This project's aim was to create an approximate estimation of the resources required for a biosecurity response based on the same FMD scenario model. The use of the calculator improved the quality of analysis of the stores required for an FMD response undertaken. This enabled the evaluation of the Stores required to meet the scenario needs which directly drove the Operational Response Stores Management Project planning. This enabled the NBCN and Operational Response Stores to be analysed determining the current state of readiness for response operations (AsureQuality, 2013w). This analysis led to decision making around the purchase or otherwise of critical stores required for the first two weeks of an FMD response (AQ, 2013i).

The development of the Operational Resource Calculator for a FMD response has enabled the prioritisation of capability to build the NBCN, the ability to plan work strategically and report

on progress through a substantive method. Capability at the start of the Biosecurity Response Services contract was established in 2009. It was estimated at 9 per cent of the requirements for an FMD response (Murray, 2011c). At the end of the 2013/14 financial year the capability increased to over 90 per cent. In addition, in an NBCN Deployment Test held in December 2013 there was 88 per cent of the capability available from the NBCN made available over the period of the test. Therefore this has been an important tool in communicating the efficacy of the NBCN for an FMD response (AsureQuality, 2014f).

FMD Modelling and Scenario

Through Biosecurity incursion modelling, Ministry for Primary Industries and AsureQuality have created a list of skills and roles which need to be fulfilled for an effective field operation response. This enables the targeting of specific organisational services to match a specific capability required in the response, such as the supply of skilled or semi skilled personnel or equipment or in some instances the supply of both (Murray, 2011d). The growth of the NBCN is the result of a focus on recruiting new members with animal response skills and working with all current members to fully understand each organisation's available capability. Through targeting the build of the NBCN, New Zealand's ability to respond to a large-scale Foot-and-Mouth Disease outbreak has dramatically improved over 2011/12 to 203/14 where animals' capability has increased from 9 per cent to over 90 per cent benchmarked against the FMD Operational Resource Calculator (AaureQuality, 2012q).

In 2013, a financial model was developed for the peak week of an FMD response, based on the Operational Resource Calculator developed from the 2011 FMD model. Assumptions were applied to enable financial data to be inputted using worst case scenario principles (AsureQuality, 2013m). This financial model has allowed MPI Finance to understand the financial implications posed by operational activities in an FMD response. In developing this model it also allowed immediate financial planning and forecasting to be undertaken at the time of an FMD response, improving response readiness (AsureQuality, 2014m).

Training testing and Exercising

The focus for training in the 2011/12 year focused on the development of training material and operational response operational experts. There were a considerable number of gaps due to the lag from the change in BRS Agreement in 2009 (where the training prior to 2009 was a

standing army concept). The new contract, and resultant paradigm shift to develop a single scalable model for response operations preparedness, led to the development of an operational response structure with four levels of roles for response operations as follows:

- Workstream Managers
- Team Leaders
- Team Members
- Operational Experts (AsureQuality, 2012g)

Arising from this change was the need for a National Response Team which could stand up a response in the first two weeks of a biosecurity emergency (AsureQuality, 2013q). A National response Team (NRT) to provide immediate first week response to a biosecurity incursion was developed over 2013 and 2014. The National Response Team is compiled of people who have already have response capability as well as those who have not yet been involved in responses but have the suitable skills and attributes to undertake a response role (AsureQuality, 2012g; AsureQuality, 2014n; AsureQuality, 2013k).

The model for training for a biosecurity response has changed with two facets, the National Response Team which will stand up the response in the first two weeks and then Training on the Day which will be implemented from day 1 of a response. Upon the initiation of a large scale response pre developed Training on the Day (TOD) material will be used to train some team members to undertake work which is similar to their day to day but requires some specific information (AsureQuality, 2012g; AsureQuality, 2014n; AsureQuality, 2013k).

The provision of specific task oriented targeted training on the day material is designed to provide over view of the response (specific response details), detail the operational role and linkage to other workstreams, clearly set out the functions of the role and the activities required and any additional knowledge and training required (AsureQuality, 2012g). The numbers required for training are determined by the biosecurity Operational Resource Calculator which identifies the areas where training and gaps in capability exist. In particular the need for planners, risk management and veterinarians has been identified (AsureQuality, 2014v).

NBCN Deployment Testing

An NBCN deployment test was undertaken in 2012 and 2013, the aim of the two deployment tests was to understand the availability of the NBCN for immediate response deployment. In the 2012 NBCN Deployment Test evaluation, the focus was on the NBCN participants' ability to have the capacity to meet their agreed minimum capacity or the capacity required for the response, the contactable nature of the NBCN membership, the time taken to get into contact and level of engagement communicated by the Membership. The 2012 NBCN Deployment test found that the NBCN participants were readily contactable while contact details required updating and some organisations were concerned around the location of the response regarding the deployment of their resources (AsureQuality, 2012e).

In the 2013 NBCN deployment test the aim was to measure the deployment capability made available in the test against the biosecurity Operational Resource Calculator to measure the NBCN's ability to be deployed for an FMD response. The 2013 NBCN Deployment test found that within a 6 hour period, 86% of the capability required for and FMD response was deployable from the NBCN for the peak week of the response compared against 87% existing capability in the NBCN at the time. There was a high level of NBCN engagement evident during the deployment test, demonstrating members' knowledge, buy in and understanding of the network and their role in a response (AsureQuality, 2014f).

The roles with less than 100 per cent capability from the NBCN Deployment Test were as follows:

Organism management:

- RP Managers;
- Slaughter staff;
- Valuers; and

Surveillance:

- Veterinarians.

Movement Control:

- Compliance (AsureQuality, 2014f)

The significant lack of Veterinarians for the Surveillance Workstream highlights the need to address the requirements for certain response operations roles. Currently there are response

operations roles which require Veterinarians which could be undertaken by non-veterinarians. In addition there is a need to continue to address the existing gaps in recruitment in Organism Management and Movement Control (AsureQuality, 2014f; AsureQuality, 2013e; AsureQuality, 2013g).

FMD Preparedness

The challenge for FMD preparedness during the transition between the old FORT and the new BRS Contract was to maintain the role holders from the FORT system until the NBCN was built to ensure that existing capability was maintained while the new system was being developed (AsureQuality, 2012k). The animals' capability from the old FORT contract pre 2009 was 9 per cent, in 2012/13 MPI requested a plan for the delivery of 100 per cent of the animal's capability by the end of June 2013 to meet the requirements of the Leadership Team (Murray, 2011d; AsureQuality, 2012k).

An FMD incursion would bring a variety of negative financial impacts on New Zealand including impacts on trade, tourism, the primary industries and the supporting industries. There would also be significant damage to the reputation of New Zealand and its brand. MPI has recently commissioned a report titled the Economic impact of FMD in New Zealand (AsureQuality, 2014t).

Using this FMD scenario and developing an Operational Resource Calculator enabled a greater understanding of the non-human resources required for an FMD response, resulting in increasing some of the critical stores items such as captive bolts to kill animals (AsureQuality, 2012a). In addition, the information from the operational resource calculator model enabled a greater insight into the areas within the NBCN where the greatest weakness exists, such as the coordination and project management required to manage the Organism Management workstream activities (AsureQuality, 2012k; AsureQuality, 2013d). This was also linked to the need to understand the scale of the plant and equipment requirements to furnish the operational resources model in the peak week of a response with over 60 infected places, where destruction, disposal and disinfection activities are all required (AsureQuality, 2013d). This important information has since been utilised by MPI directly for the FMD Disposal Project (AsureQuality, 2014t).

The creation of the Operational Resource Calculator highlighted the lack of expertise which existed in the NBCN to manage the Organism Management workstream. This resulted in the

decision to go to market to contract an organisation directly to undertake this work in an FMD response (AsureQuality, 2012q; AsureQuality, 2014h). Surveillance Capability is another area which has been highlighted as a risk for FMD preparedness as a result of the output from the Operational Resource Calculator. The availability of veterinarians in New Zealand and in the NBCN is significantly less than the number required in an FMD response. Looking at alternative ways to address these capability gaps has identified options which may be employed if a response was initiated (AsureQuality, 2014h).

Relationship and leadership

The BRS Agreement signed in 2009 by MPI (formerly MAF) and AsureQuality set out the objective of AsureQuality's relationship to provide MPI with an effective process for managing and accessing the widest practical network of capability and to have a timely and scalable method to deploy the ability for biosecurity responses operations. The objective of the National Biosecurity Capability Network was to deliver effective and efficient biosecurity incursion readiness and response outcomes for New Zealand (MAF, 2009). The 'best capability' concept was developed, determined by criteria including cost, value for money, skills, building capability, the suitability for purpose, location and use of resources across the capability network regardless of ownership (AsureQuality, 2012q).

The objective for the Annual Business Plan for the Biosecurity Response Services contract was stated as follows:

- Develop the capability network
- Develop response capability, and
- Develop the support framework (MAF, 2009 p.20)

Sustainable and effective response capability was defined in 2012/13 BRS Tactical Plan as:

a. Access to the resources needed for a biosecurity response through one channel;
b. Knowing and understanding what capability is available, what is needed, and capability gaps are managed;
c. NBCN Participants in responses are well prepared and perform well;
d. Effective and efficient systems to manage capability and response information;
e. Robust response operations plans in place and tested for responses;

f. Effective communication and reporting based on a "single source of the truth"; and

g. Stakeholders tell MPI that the NBCN, biosecurity preparedness and response are effective and efficient (AsureQuality, 2012j)

A key message from the BRS Leadership Team was that the tactical plan for 12/13 was the goal of attaining 100 per cent animals capability and reflect a plan with a total view of elements required for a response (AsureQuality, 2012q). MPI took the lead role in building the National Biosecurity Capability Network (NBCN) for the remainder of the 2012/13 year. The result of this shift in shared leadership to build the NBCN was the recruitment of MPI in the NBCN and the extension of the NBCN membership to include government agencies and departments (AsureQuality, 2013s).

At the onset of the BRS Agreement in 2009 there were significant opportunities seen by MAF for improvement and innovation which required AsureQuality to grow the NBCN concept. These opportunities included the identification of gaps in capability and recruitment of organisations into the NBCN, the development of alternative methods to deliver response operations activities, to recruit organisations into the NBCN and fill capability gaps. In addition, the development of scenarios and benchmarks would enable additional measures of effectiveness for the NBCN to be reported and response preparedness increased (MAF, 2009; AsureQuality, 2012g).

To summarise this chapter, there has been a significant change in developing operational resource capability for biosecurity response preparedness from the 2009 BRS Agreement to the current state in 2014. The change from former FORT model with a standing army approach to the current National Biosecurity Capability Network (NBCN) approach to operational capability has been a huge transition. The Biosecurity Response Services contract, in place since 2009, has led to a complete transformation in response operations preparedness approach. The use of the Operational Resource Calculator has enabled measuring level the capability held in the NBCN, identifying gaps and supporting testing activities for deployment. This has been significant in the ability to and measuring of operational capability easily and report with quantitative ease. The use of the calculator has also supported detailed planning equipment for operational activities, financial modelling for

operational activities and has the flexibility to be modified to response to different scenarios in the future.

Chapter 5 Analysis of Results

Introduction

The purpose of the following chapter is to compare and contrast the themes which were presented in the previous results chapter Biosecurity Response Services contract case study 2011-14 with the themes which have been drawn out from the three New Zealand Emergency Events in the past five years. These groups of themes will be compared and contrasted, identifying the common elements which pertain to generic preparedness and identifying the role played by the development of the Operational Resource Calculator in aiding and informing biosecurity response preparedness.

The key themes from the 2011 to 2014 BRS Contract are as follows:

1. **Capability, Building the NBCN for Biosecurity Preparedness,** This theme is defined as the development of the National Biosecurity Capability Network to becomes New Zealand's field operations team for a biosecurity response
2. **Resource requirements, Measuring Biosecurity Response Preparedness,** The methods and tools used to measure understand and report on the level of capability and capacity in the NBCN measured against the Foot-and-Mouth Disease (FMD) Operational Response Calculator.
3. **Training, Testing and Exercising,** Training for operational response management and the roles required. Testing is defined as measuring the NBCN capability and the ability to deploy the network quickly. Exercising is simulating a response activity and practicing what has been learned in the training and putting this into practice.
4. **FMD Preparedness,** Foot-and-Mouth Disease preparedness for the implementation of operational activities in the field, the ability to undertake the tasks required of the five operational workstreams, Surveillance, Organism Management, Movement Control, logistics and Operations Management.
5. **Relationships and leadership,** Relationships is the agreement between with AsuerQuality and the Ministry for Primary Industries (MPI) and leadership is the act of forwarding biosecurity response operations preparedness through the use and management of this relationship,

The Preparedness themes from the Pike River 2010, Christchurch Earthquake 2011 & 2012 and the PSA Kiwi Fruit Biosecurity Response 2010 are as follows:

a) **Leadership,** at the national, regional, local, and site level is critical

b) **Capability**, the identification of people for key roles with the right competencies independent of the organisation that employs them

c) **Training,** of people in key roles to enable them to know what is expected and to develop specialised expertise in a biosecurity response and the selection and deployment of these people into the role in the event of a response

d) **Exercising**, of people and organisations to test plans, establish relationships, develop competency, understand capabilities, and boundaries in peacetime

e) **Planning,** the development of response plans involving expertise in all relevant areas including biology, epidemiology, operations, logistics, industries, affected parties, stakeholders, and emergency management

f) **Systems**, the development of systems, and the processes and procedures to support use of the systems, to manage information based on pre-agreed reporting requirements in a response

g) Resource requirements, knowing and understanding what resources are required and available for a response, understanding how to access and deploy these resources, and the ability to coordinate an emergency response between different organisations

h) **Information,** the provision of timely, accurate information to the affected people and organisations in a suitable and appropriate format. (AsureQuality, 2013v)

The following section will compare and contrast the themes which have been elucidated from the BRS case study 2011-14 and the themes from the three New Zealand events over the past five years. The corresponding themes are grouped together in Table 3 below. An analysis of each thematic area will follow, examining the associations and connections which exists and the similarity or otherwise in the factors which make up each thematic area.

Table 3: Comparison of themes – BRS Contract 2011-14 and Three New Zealand Emergency Events Consolidated Preparedness Themes – Pike River, Christchurch Earthquake and PSA Response

Year	BRS Contract 2011-2014	Three New Zealand Emergency Events Consolidated Preparedness Themes – Pike River, Christchurch Earthquake and PSA Response
Response Capability	**Capability, Building the NBCN for Biosecurity Preparedness,** This theme defined as the development of the National Biosecurity Capability Network to becomes New Zealand's field operations team for a biosecurity response	**Capability**, the identification of people for key roles with the right competencies independent of the organisation that employs them
Resource Requirements	**Resource requirements, Measuring Biosecurity Response Preparedness,** The methods and tools used to measure understand and report on the level of capability and capacity in the NBCN measured against the FMD operational response calculator	**Resource requirements**, knowing and understanding what resources are required and available for a response, understanding how to access and deploy these resources, and the ability to coordinate an emergency response between different organisations
Training, Testing and Exercising	**Training, Testing and Exercising,** Training for operational response management and the roles required. Testing is defined as measuring the NBCN capability and the ability to deploy the network quickly.	**Training,** of people in key roles to enable them to know what is expected and to develop specialised expertise in a biosecurity response and the selection and deployment of these people into the role in the event of a response **Exercising**, of people and organisations to test plans, establish relationships, develop competency, understand capabilities, and boundaries in peacetime
Preparedness Planning	**FMD Preparedness,** Foot-and-Mouth Disease preparedness for the implementation of operational activities in the field, the ability to undertake the tasks required of the five operational workstreams, Surveillance, Organism Management, Movement Control, logistics and Operations Management.	**Planning,** the development of response plans involving expertise in all relevant areas including biology, epidemiology, operations, logistics, industries, affected parties, stakeholders, and emergency management
Relationships and leadership	**Relationships and leadership,** the agreement between with AQ and MPI and leadership is the act of forwarding biosecurity response operations preparedness through the use and management of this relationship,	**Leadership,** at the national, regional, local, and site level is critical
Systems		**Systems**, the development of systems, and the processes and procedures to support use of the systems, to manage information based on pre-agreed reporting requirements in a response
Information		**Information,** the provision of timely, accurate information to the affected people and organisations in a suitable and appropriate format.

Comparison of Themes

The themes presented from the BRS case study 2011-2014 and the Three New Zealand Emergency Events in the past five years are presented in Table 3 above. There are a number of similarities and overlaps apparent. The themes which shared across the two groups are those of Capacity, Resource requirements, Training, Exercising, Leadership and Planning /FMD preparedness.

Resource requirements

Basic preparedness planning is supported by an understanding of the estimated resource requirements prior to an emergency event. In addition, the understanding of the availability or otherwise of resources before an event occurs contributes to robust emergency preparedness planning. Measuring having both people and non-people resources requirements is not enough in isolation; having a system to access and deploy these resources and coordinate the sources of resources is an important factor in effective response management and response preparedness. While this was touched on in both the BRS case study 2011-14 and the three New Zealand Emergency Events, the existence of a robust system to coordinate resources requirements and needs is not given a high level of importance. This gap is especially noticeable in the BRS case study 2011-14, where it has not come through as a preparedness theme. This is potentially an important gap in this preparedness work, where the collective coordination of resources from a wide range and number of organisations in the NBCN would in a large scale event require coordination. If the coordination of resources is not managed well the confidence and faith in the NBCN could be undermined. There is also a significant requirement to have the ability to coordinate an emergency response managed by a number of different response organisations.

The development of an NBCN Information Management System is crucial to managing a response and understanding what resources exist where measuring these against the Operational Resource Calculator sets out the resource requirements for a biosecurity response. The Operational Resource Calculator is used to measure, benchmark, understand and report the level of capability and capacity in the NBCN for biosecurity response operations for an FMD response.

Capability

Having the people capability to respond to an event, whatever the emergency, is necessary for effective response outcomes. In both the BRS case study 2011-14 and the three New Zealand Emergency Events, the theme of 'capability for event' was common. The management of capability however is not simple; it requires the prior identification of the capability required and the structure and roles to be in place to position the right people in the right place and systems to manage this. For biosecurity response preparedness in particular the development of the National Biosecurity Capability Network has developed a large pool of suitable organisations with individuals within it which have suitable capability to fulfill response operations roles, the choice of these individuals is independent of the organisation which employs them.

Developing an Operational Resource Calculator for a biosecurity incursion assists in understanding the numbers and the types of capability required for an FMD response. Having clear numbers against roles supports targeted and deliberate recruitment of skills and organisations into the NBCN. The Operational Resource Calculator provides a very clear and measurable guide where capability gaps can then be addressed either through recruitment or training. In particular, the Operational Resource Calculator has enabled the reporting of the current biosecurity response capability status against the FMD model, providing MPI with a clearer understanding and awareness of the level of response capability which exists, enabling operational preparedness to be quantified.

Training and Exercising

The need for training, exercising and testing of capability for operational response roles required to support positive response outcomes is borne out in both the BRS case study 2011-14 and the three New Zealand Emergency Events. Training is deemed necessary where these response operations roles require specific knowledge or leadership. Also for the first two weeks individuals will be required to stand up and manage the response operations from the onset of the incursion.

Part of training process includes exercising which is a fundamental part of the National Response Team biosecurity training for teams which will manage the operational management of the response for the first weeks. Exercising allows people and organisations

to test operational response plans, establish relationships, develop competency and understand capabilities which aids response performances and relationships.

The development of the Operational Resource Calculator for response operations supports the quantification of the training numbers required for the first week of an FMD response, it also helps identify the training requirements for people with specific specialist skills required to manage specific areas of a biosecurity response operation.

Leadership

Leadership as a theme has been identified in both the BRS case study 2011-14 and the three New Zealand Emergency Events. In the latter case, this theme is presented in context of structure and hierarchy within the formation of the response management structure, necessary to enable command and control. In the BRS case study 2011-14, leadership is a key theme due to recent timeframe of this contract from 2009-2014 and the paradigm shift being implemented as a result. Therefore leadership in this context is leading biosecurity response operations preparedness through the use and management of this relationship, between the MPI and AsureQuality. Key areas include guiding the development and growth of the NBCN model, seeking guidance on opportunities and identifying further potential. National, regional and local leadership is not clearly in place for biosecurity response operations, further change to respond to the changes in the CIMS2 structure.

The use and existence of the response operations calculator and resource modelling cannot be linked directly to the development or the effectiveness of leadership in biosecurity response preparedness.

Planning /FMD preparedness

Planning for responses and in particular for high risk biosecurity responses such as FMD is common to the themes presented in both the BRS case study 2011-14 and the three New Zealand Emergency Events. Planning is based on the worst possible outcome, developing policies and procedures for operations and developing structures which can align to support operation preparedness. The MPI FMD preparedness work has informed the range of field operational activities, this will provide clear operational plans for the five operational workstreams, Surveillance, Organism Management, Movement Control, Logistics and Operations Management.

The Operational Resource Calculator supports the capability aspect of this planning; the calculator itself will be informed and changed by amendments to areas of policy, procedures and structure at each level down to the farm or field level.

Contrasting Themes

The themes presented from the BRS case study 2011-2014 and the three New Zealand Emergency Events in the past five years which differ include Systems, Testing, Relationships, and Information.

Testing

Testing the NBCN's efficacy uses the Operational Resource Calculator as a metric to understand NBCN capability and ability to deploy the network quickly. This theme of testing was not a key theme in the three New Zealand Emergency Events, an observation on the reason or this omission may be that existing emergency services are tested on a daily basis and do not need to prove their efficacy. In contrast, the youth and unproven ability of the NBCN as an operational mechanism to provide specialist capability for a biosecurity incursion requires testing to prove its efficacy. In addition, the specialist nature of biosecurity capability may require more focus on testing the availability of people and organisations with specialist skills such as Veterinarians. Moreover, testing plans for large scale civil emergencies is identified under the exercising theme which may be a priority focus due to the availability of emergency services personnel in New Zealand.

Testing the deployment of the NBCN using the Operational Resource Calculator has developed the faith and confidence in the network to be gained by the Ministry for Primary Industries. The results of this NBCN deployment test against the FMD scenario measured against the Operational Resource Calculator in 2013 provided substantive proof that the NBCN had the deployable capability available in a short period to respond to a large scale FMD response.

Systems

While Systems as a theme was present in the three New Zealand Emergency Events this was omitted from the key themes in the BRS case study 2011-2014. Despite the reference in the Capability theme to the importance of systems to manage capability and resources this has not been prioritised in the first five years of the BRS Contract which was initiated in 2009. The omission of this theme in the three year period may be attributed to the need to develop the NBCN in size and breadth before a system is in place to manage a large scale response requiring over 6000 people in the peak week (MPI, 2014). The implementation of the NBCN Information Management System has addressed the immediate issue to act as a repository for the NBCN capability. Therefore the lack of focus on deployment systems five years into building the NBCN may be due to the rationale to stagger the development of large scale infrastructure and systems until the NBCN is tested and the breath of the systems requirements is understood.

Nevertheless the need to develop systems to deploy and coordinate resources is acknowledged, the need to manage these resources at the differing levels, national, regional and local is also understood and once developed, systems will require testing and training, which is a key theme, to enable effective use in a large scale response event.

Relationships

Relationships were a key theme which came out of the BRS case study 2011-14 while it was omitted in the three New Zealand Events in the past five years. The inclusion of this theme in the BRS case study 2011-14 can be related to the contractual relationship between MPI and AsureQuality, the development of a new operational response paradigm and the change management required on both sides. There is a requirement for the two organisations to work closely in peacetime as well as in an event, where strong relationships have supported a robust working relationship within the management of the BRS contract.

Without a strong relationship, leadership becomes less effective. The need for a positive interrelationship between the two organisations, AsureQuality and MPI, was identified in the founding BRS Agreement signed in 2009 where it was stated that the leadership role of MPI was that of forwarding biosecurity response operations preparedness through the use and management of this relationship (MAF, 2009).

In relation to generic response events, the existence of the CIMS structure does not negate the need for strong and positive relationships. CIMS can therefore, through its ability to develop clarity in roles and structure, aid better relationships, reducing ambiguity and supporting better interagency cooperation (ODESC, 2014).

Information

The theme of Information was omitted from the BRS case study 2011-14 key themes, while significant within the recommendations of the reports from the three New Zealand Emergency Events. The provision of timely, accurate information to the affected people and organisations in an event in a suitable and appropriate format is important. This relates to both the management and leadership of the response itself and also to the psychosocial aspects of recovery post event. The provision of information to those affected reduces the event horizon which reduces the psychological impact of the event on individuals, families and communities (Paton el al, 2008; Walsh 2007). A lack of information and unresponsiveness especially by larger organisations may resultantly compound the traumatic impact of the event (Walsh 2007).

Summary

There is significant commonality in the themes which have arisen from the Biosecurity Response Services case study 2011-14 and the three New Zealand Emergency Events in the past five years. These convergent themes include: Capacity Resource requirements, Training, Exercising, Leadership and Planning /FMD preparedness. While this is the case there are themes which differ, these include: Information, Systems, Testing and Relationships. The relationships with these themes and how Operational Resources Calculator contributes to preparedness within these key areas will be discussed in the following Discussion Chapter 6.

Chapter 6 Discussion of Results

Introduction

The following section reviews how the themes from the BRS case study 2011-14 and the three New Zealand Emergency Events in the past five year align, including a discussion on the reasons for any variations. This section will also cover a discussion of the preparedness themes which are linked or related to the use of the Operation Resource Calculator and how they contribute to biosecurity response preparedness.

Alignment and Variation of Themes

The four themes which aligned between the BRS case study 2011-14 and the three New Zealand Emergency Events in the past five years were: Resource Requirement, Capability, Training, Leadership and Planning.

Where a difference occurred between the BRS case study 2011-14 and the Three New Zealand Emergency Events in the past five years was the omission of Systems and Information themes from the BRS Case Study 2011-14 work. The reasons for the omission of these themes can be attributed to the lack of maturity of the BRS Contract, signed in 2009. The youth of the NBCN may be attributed to the lack of focus on robust systems for large scale capability deployment at this stage in the process of building the capability within the NBCN and before developing systems for response deployment.

The omission of the theme of Information as an area of focus for the BRS case study 2011-14 has been attributed by the author to two factors. The first factor is that biosecurity responses have a highly technical focus which has been overemphasised above the social needs of the community. The second is the relative lack of integration of emergency risk communication theory into the area of biosecurity response management. The lack of integration of wider emergency management concepts and learnings into the area of biosecurity response operations management may be attributed to the lack of understanding and awareness of how a biosecurity response can affect the wider community. Currently the focus is on resourcing the technical aspects of biosecurity responses to establish and maintain preparedness for an incursion, the priority to deal with the technical operation therefore takes precedence over the provision of information to the communities and groups affected by the response.

In addition, the themes of Testing and Relationships were observed to be present in the BRS case study 2011-14 but lacked presence in the literature reviewed for the three New Zealand Emergency Events in the past five years. A reason for the focus on Relationships in the BRS case study 2011-14 can be attributed to the need for the two organisations, AsureQuality and MPI, to work closely together in peace time and in a response. The reason this is significant is that MPI contract out the operational activities required in a response, which is contrary to what the Police or Fire Service do. A focus on the improvement in this key relationship in peacetime has merit in supporting an increase in confidence in a response situation, where trust and communication are necessary.

The focus on the Testing theme in the BRS Case Study 2011-14 is clearly in context of testing the NBCN capability and understanding its value or it efficacy. Given the youth of the network, five years old in October 2014, the focus on testing and the level of importance attributed to this is understandable. Also given the fact that AsureQuality are contracted to build and develop the NBCN, testing this and proving success and proving efficacy helps build confidence in the mind of the Ministry. There is a clear difference between the NBCN and the existing Emergency Services in New Zealand. The youth of the NBCN as an operational resourcing mechanism is a significant paradigm shift which sits in stark contrast to the long established nature of most of the Emergency Services in New Zealand. The youth of the NBCN is significant factor why testing has arisen in the BRS Case study 2011-14.

Operational Resource Calculator link to preparedness Themes

The four thematic areas within the BRS Case Study 2011-14, which were either dependent upon or required the use of the Operational Resource Calculator were Resource Requirements, Capability, Training Testing and Exercising and Planning.

The ability to understand, quantify and measure the resource requirements for an FMD response was enabled by the development of the Operational Resource Calculator for FMD. This has contributed to FMD preparedness in two main areas; it has supported a high level of understanding of the resource needs for operations for an FMD response. Understanding the quantity of people and non-people resource needs for an FMD response has facilitated detailed reporting, measuring and benchmarking existing capability against the Operational Resource Calculator. Understanding this level of resource detail also highlights any gaps

which might exist in resourcing, a factor which drives the preparedness work under the BRS contract.

The priorities for building response capability for an FMD response have been determined using the Operational Resource Calculator. This tool has supported the recruitment work undertaken to build the NBCN, helping to drive decisions to recruit the right capability to target gaps for an FMD response. In terms of capability requirements it also supports arguments to change policy around skill or qualifications required for certain response operations roles.

The use of the Operational Resource Calculator has contributed to the theme of training testing and exercising where the calculator helps establish high level planning goals for the roles which require training. Also it helps determine what skills are required, what level of training is required and the number required for the National Response Team for the first week of an FMD response. The quantification of people resources required enables accurate deployment testing of the NBCN and a measure of deployable capability against the Operational Resource Calculator for a peak week of an FMD response while also identifying capability gaps. For exercising, the scenarios developed to build the Operational Resource Calculator help develop realistic situations to aid preparedness.

Planning, and in particular the theme of FMD Preparedness, has a different relationship with the Operational Resource Calculator where the FMD preparedness work, which is undertaken by the MPI FMD Programme, will result in changes to the resource calculator. Reasons behind this relate to changes in policy which affect operational plans which will affect the resources required for operational tasks in the field such as destruction and disposal of animals, and the introduction of different response strategies e.g. vaccination instead of destruction of non-infected animals. The result of the operational requirements changes introduced from the MPI FMD Programme include but are not limited to changes in the composition of teams at a farm level to manage response operations for an FMD response. While this programme of work is not yet completed, changes in the types of roles and numbers contained in the tool are inevitable and will be required to be amended to reflect this work.

Because the Operational Resource Calculator is flexible it can respond to changes which arise from updating policies and operational plans. These changes in the calculator will resultantly have a direct flow on affect on people and non-people resources required, redirecting NBCN recruitment targets and changes to training requirements amongst others. This supports informed strategic planning to continue to address areas of capability, resources, training requirements etc. while enabling the NBNC to be tested against the revised resource needs identified.

Conclusion

To conclude this chapter, there are variations and similarities in the themes from the BRS case study 2011-14 and the three New Zealand Emergency Events in the past five years. The use and significance of the Operational Resource Calculator was outlined and its role in driving the current biosecurity response preparedness work was discussed. The use of the calculator itself going forward will clearly need to be iterative and flexible to respond to changes in policy, structure and operational specifications for FMD.

Chapter 7 Recommendations

Introduction

The following chapter is the conclusion to this dissertation. This chapter will present a number of recommendations which can be applied to future work in the implementation of the Biosecurity Response Services contract. These recommendations are conclusions which are derived from the Discussion of Results and Analysis chapters 5 and 6 where the themes from the three New Zealand Emergency Events in the past five years and the BRS contract 2011-14 case study were compared and contrasted and the salient aspects discussed.

Recommendations for Best Practice for Biosecurity Preparedness

The recommendations for best practice for biosecurity preparedness are as follows:

Recommendation 1 - Increase awareness of the importance of proactive and targeted operational communications and information for the community affected by a biosecurity response.

Recommendation 2 - Develop systems for large scale resource management and deployment for biosecurity responses

Recommendation 3 - Continue to test and measure the National Biosecurity Capability Network (NBCN) and use the Operational Resource Calculator to build confidence and report growth in biosecurity operational response capability.

Recommendation 4 – Implement a flexible use of the FMD Operational Resource Calculator.

Recommendation 5 - Draw on emergency management learning's and principles for future biosecurity response preparedness and response management.

Communications/Information

Recommendation 1

Increase the awareness of the importance of proactive and targeted operational communications for the community affected by a biosecurity response.

The need for communication was very clear from the Christchurch Earthquake Royal Commission and if there is a Foot-and-Mouth Disease (FMD) outbreak in New Zealand, communication and information will be paramount in an operational capacity for two reasons. Firstly, providing information early will help to get the community working with the operational activities happening on the ground. Secondly to reduce the event horizon, where the provision of information to a community can reduce the sense of trauma and help psychosocial recovery faster in spite of the event itself (Paton el al, 2008; Walsh 2007). Also, if there is not communication and information provided to communities in a sufficient manner, the learnings from the Christchurch Earthquakes will not have been implemented, undermining the value of these expensive and timely reviews.

Systems for Resource Management

Recommendation 2

Develop systems for large scale resource management for biosecurity responses

There is a need to focus on developing the systems to manage the resources which are gathered to enable successful large scale deployment for a biosecurity response. What is clear from the review of the Three New Zealand Emergency Events is that without robust systems in place, resources and resource management will fall down and hamper a positive result.

Continue to Test and Measure NBCN

Recommendation 3

Continue to Test and Measure the National Biosecurity Capability Network and use the operational calculator to build confidence and report improvement.

Due to the youth and the relative uniqueness of the NBCN continuing to test and measure the National Biosecurity Capability Network (NBCN) capability is recommended. This will

allow the network to remain a trusted tool for biosecurity response capability and help political pressure around the cost of maintaining the NBCN. Also, what came out the three New Zealand Emergency Events in the past five years was to identify individuals who can set up and manage and EOC immediately which is similar to the existing National Response Team (NRT) for biosecurity events. The ability to prove the operational ability of the NBCN and the NRT ensures investment in these structures for biosecurity preparedness.

Continue to measure capability against the Operational Resource Calculator is related to Recommendation 3 where testing the NBCN is supported. While this recommendation may seem obvious, the ongoing use of the Operational Resource Calculator enables continuous measuring of the operational capability which exists for a biosecurity response. The use of the Operational Resource Calculator enables dashboard reporting on preparedness for high level communication within the Ministry for Primary Industries and also helps focus ongoing recruitment to the NBCN to address capability gaps.

Flexible use of Operational Resource Calculator

Recommendation 4

Flexible use of the FMD Operational Resource Calculator

The Operational Resource Calculator itself will change in the future. Enabling an approach which is flexible will enable an iterative tool which can respond to changes in policy, structure and operational specifications for FMD. The challenge will be to socialize why there are changes in the percentage capability levels in the NBCN against the models and specifically the FMD operational Model which is responding to changes in policy, structure and operational specifications.

Draw on Mainstream Emergency Management Theory and Principles

Recommendation 5 - Draw on emergency management theory and principles for future biosecurity response preparedness and response management

This is an overarching recommendation to reduce the level of isolation in Biosecurity response preparedness with the wider emergency management field. The lack of attention to key themes such as communication and information is indicative that integration is not in place. With the current level of media attention and proliferation of media sources, not giving attention to the public and communities affected by a biosecurity response is ill advised.

Conclusion

To conclude, Operational Resource Calculator Modelling has enabled the growth of the National Biosecurity Capability Network to be measured and the preparedness developed quantified. This resource calculator has supported and driven recruitment to the NBCN to address capability gaps required for a large scale FMD response. The benefit of this tool has been to aid reporting, helping the Ministry for Primary Industries to understand the level of preparedness which exists at any point in time and gauge the progress being made in the Biosecurity Response Services contract. The Operational Resource Calculator has also supported significant testing of the NBCN's capability to respond which is a new concept. Without this tool it would be impossible to add a metric to the level of operational biosecurity response capability which exists to respond to a large scale incursion.

Two of the recommendations; Recommendation 1 to increase the awareness of the importance of proactive and targeted operational communications for the community affected by a biosecurity response and Recommendation 2 develop systems for large scale resource management for biosecurity responses, are unrelated to the Operational Resource Calculator. The other three recommendations are directly related to using the Operational Resource Calculator to support preparedness for biosecurity responses, by testing the NBCN capability, ongoing measuring of NBCN capability and using the Operational Resource Calculator as a flexible iterative tool to develop biosecurity operational preparedness.

How has ‘Operational Resource Calculator contributed to building biosecurity preparedness in New Zealand: A case study of the use of a Foot-and-Mouth Disease was the research question. The use of the Operational Resource Calculator has enabled the capability within the NBCN for response operations to be planned, giving strategy for recruitment to grow NBCN membership. Having a quantifiable calculator the NBCN membership has been able to be tested for deployment capability and capability can be measured regularly in peacetime. This has proved important for political support of the network, trialling a potentially risky new model for operational biosecurity preparedness. In addition the Operational Resource Calculator can be used as an iterative tool to measure against future FMD models developed which gives this tool longevity and a lasting role in developing and maintaining biosecurity response operational preparedness.

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Appendix a Analysis of Codes linked to themes presented in each contract year

Analysis of codes linked to themes presented in each contract year

Year 2011_12	2011-12 Key Themes	2011-12 Codes
Capability	Building the NBCN For Biosecurity	Cooperation – One Team NBCN Development – Capability inventory sources Systems - Information Management system – NBCN Database Communication Sustainable Relationships - NBCN engagement Building NBCN - Recruitment Agreements - Capability Relationships Plans Priorities to build response capability - Increase in NBCN capability - NBCN resources Industry Needs Recruitment Regional councils NBCN Collateral NBCN Supplier Recruitment NBCN Participation in Responses
Response Structure	Biosecurity Response Structure	Change/New Direction Biosecurity Response Resource Needs MAF's response model, processes and tools Changes to the response structure Biosecurity Operations Response Structure Generic Responses Operations Response Roles
FMD	FMD Response Preparedness	Response Readiness FMD Readiness FMD Response Stores FMD Operational Response Calculator FMD Model FMD Simulation Participation FMD Response FMD Scenario FMD Capability
Measuring Response Preparedness	Measuring Biosecurity Response Preparedness	Generic and Expert Capability Best capability Develop incursion models to understand capability needs Benchmark for planning - capability Analysis of elements required Target for recruitment Understanding current readiness Report on progress Maximum and minimum capability Stores requirement for FMD Progress Reporting
Training/Testing/Exercising	Training Exercising and testing	Test Capability and Capacity of NBCN Exercise Planning Programme NBCN Deployment People Capability Generic Training - Training Resource availability
Relationships and leadership	Strong Contractor / MPI Relationships	Stable Environment Plan, innovate and invest Link to other work Strategy to develop relationship

Year	2012_13	Codes
Capability	Building the NBCN For Biosecurity	Communicating results NBCN Growth – numbers and sectors, industry groups NBCN Recruitment priorities and targets MPI membership of the NBCN All of government in NBCN GIA & Industry growth Increase sectors in NBCN NBCN Membership Engagement Stakeholders Cost of resources – baseline for NBCN Engagement

		Stakeholder Consultation NBCN Capability Systems to manage NBCN Use of NBCN Suppliers for response stores Tactical planning
Response Structure	Biosecurity Response Structure	Response Outcomes Response Operations Stores Response Tools and Systems Response Preparedness Response Performance Measures
FMD	FMD Response Preparedness	FMD Operational Capability FMD Response Preparedness MPI FMD Policy
Measuring Response Preparedness	Measuring Biosecurity Response Preparedness	Incursion Modelling to prioritise capability gaps FMD Scenario modelling Measuring against the FMD operational model Priorities for recruitment Generic capability Resources required for FMD Ground Truthing of models developed Understanding industries ability to provide capability Alternative surveillance options needs Deployment of capability Revaluate response operations Audit capability Targets for NBCN Measuring current state against requirements Readiness for urgent or critical stock Reporting Operations Measuring progress Plant and Equipment modelled Monitoring 100% animals capability Targets and Measures Scenarios Benchmarks Scenario development
Training/Testing/Exercising	Training Exercising and testing	Training requirement Training needs Training on the day National Response Team Response Training Training Strategy NBCN Training
Relationships and leadership	Learning and Leadership	Identify public discomfort MPI satisfaction measured Partnership Leadership Response Debrief Learning's Response Debrief action plans Strategy

Year	**2013_14**	**Codes**
Capability	Building the NBCN For Biosecurity	NBCN Capability NBCN Membership Engagement Rebranding NBCN NBCN response capability measured Suitable capability Stores management – critica stores, NBCN suppliers Sustainable and effective response capability Preparedness Operations management/RP management GIA NBCN IMS System – reporting NBCN growth Use of NBCN outside of Biosecurity Organism Management capability

		Marine Capability
Response Structure	Biosecurity Operations Systems	Costs Project Management Organism Management Response Systems Response Management Response Planning
FMD	FMD Response Preparedness	FMD Preparedness FMD Response Exercise FMD Preparedness Priorities
Measuring Response Preparedness	Measuring Biosecurity Response Preparedness	FMD Operational Resource Calculator FMD Model Scenario Response capability Analysis of NBCN members capability against the models Marine Operational Resource Calculator People and Equipment Scalable response model Resource modelling Gaps - Targeted approach - Outcomes and targets Resource modelling Marine Modelling
Training/Testing/Exercising	Training Exercising and testing	NRT Training Deployment of NBCN Confidence in NBCN Training requirements Training Plan Requirements for training measured against the model Audit standard BRS Internal Audit Deploying GIA partners in a response NBCN FMD Capability Testing against FMD Model Industry Testing Fruit Fly Deployment Test
Relationships and leadership	Strong Contractor / MPI Relationships	Leadership Management Standard Improvements