cebra

Centre of Excellence for Biosecurity Risk Analysis

ANNUAL REPORT

2018–2019

Australian Government
Department of Agriculture

THE UNIVERSITY OF MELBOURNE

Ministry for Primary Industries
Manatū Ahu Matua

CONTENTS

DIRECTOR'S INTRODUCTION

It is my privilege and pleasure to introduce the 2018–19 Centre of Excellence for Biosecurity Risk Analysis (CEBRA) annual report.

As managing director for the Centre of Excellence for Biosecurity Risk Analysis, I welcome readers to our annual report for the year ended 30 June 2019.

Biosecurity in Australia, and around the world, is an ever-shifting puzzle. Changing human activity and climactic conditions affect the nature of the biosecurity risks confronted by industry, environment and people. In the face of this evolving challenge, CEBRA supports the Australian and New Zealand governments through practical, responsive research. CEBRA is uniquely placed: our connection to government keeps our research focused on relevant, pressing problems while our position at the University of Melbourne allows us to share and access cutting-edge scientific techniques.

Responding to complex biosecurity problems requires a strong team. These past twelve months, deputy directors Steve Lane, Susie Hester and Aaron Dodd have done an excellent job of steering CEBRA toward high-quality research outcomes for our stakeholders. In particular, I'd like to thank Steve, who recently departed CEBRA to take up a role at WorkSafe Geelong, for his efforts. We also farewelled Rezvan (Rose) Hatami, who provided valuable input into projects as well as organising the CEBRA seminar series during her time at CEBRA. We wish Steve and Rezvan all the best for the future.

CEBRA researchers regularly attend and host conferences and gatherings. A highlight from earlier in the year was the first Australian Biosecurity Symposium, which I attended with Susie Hester and Aaron Dodd. Hosted by Animal Health Australia, the Invasive Species Council Australia and the Centre for Invasive Species Solutions, the event drew close to four hundred delegates, and was an excellent chance to network and share knowledge.

In the past twelve months, CEBRA has held a number of successful CEBRA seminars. Talks featured work by scientists and practitioners over a range of subjects, including mathematical and statistical modelling, resource allocation and remote sensing of biosecurity infestations. Forums like this are an excellent opportunity for exchanging knowledge across disciplines.

Maintaining strong connections with our colleagues in the Department of Agriculture and the Ministry for Primary Industries (MPI) is crucial to our ability to produce impactful research. We value regular communications with our government colleagues and I thank them warmly for their continued engagement and input into all stages of the project lifecycle, from inception to completion.

Associate Professor Andrew Robinson
Managing director, CEBRA

CORE ACTIVITIES

SUMMARY OF CORE ACTIVITIES

The core activities that CEBRA undertook during the financial year 2018–19 comprise the following projects, approved by the Biosecurity Research and Innovation Steering Committee.

Table 1 : Core activities for 2018–2019

Project	Title	2018–2019 Budget
	Strengthening Surveillance	
170602	Increasing confidence in pre-border risk management	$107 000
170606	Developing models for the spread and management of national priority plant pests	$84 840
170607	Developing scientifically robust risk maps for priority plant pests	$130 000
170608	CBIS/CSP sensitivity analysis	$62 000
170615*	Assessing ant pathways to better inform site selection for ant surveillance	$91 500
170621*	Proportional value of interventions across pathways and layers of the biosecurity system (extension of 1606E)	$45 000
180601*	Models for border inspection for pelleted seeds: how much assurance?	$50 000
	Building Scientific Capacity	
170713	Value of Australia's biosecurity system (extension of 1607A)	$236 000
170714	Health of Australia's biosecurity system (extension of 1607B)	$260 000
180702*	CEBRA research: harnessing past and new work to improve uptake and impact of best practice risk analysis approaches in MPI	$31 000
	Data and Information	
170805	Optimisation of national resources for animal disease surveillance	$149 904
	Total:	**$1 247 244**

*Ministry for Primary Industries led projects

July 2018 – June 2019

Strengthening surveillance $570 340

Project ID: 170602 SH
Project Title: Increasing confidence in pre-border risk management
Division: Biosecurity Animal
2018–19: $107 000

Project ID: 170606 TK
Project Title: Developing models for the spread and management of national priority plant pests
Division: Biosecurity Plant
2018–19: $84 840

Project ID: 170607 AR
Project Title: Developing scientifically robust risk maps for priority plant pests
Division: Biosecurity Plant
2018–19: $130 000

Project ID: 170608 SH
Project Title: CBIS/CSP sensitivity analysis
Division: Biosecurity Plant
2018–19: $62 000

Project ID: 170615 ❖AR
Project Title: Assessing ant pathways to better inform site selection for ant surveillance
Division: NZ MPI DSSO
2018–19: $91 500

Project ID: 170621 ❖AR
(extension of 1606E)
Project Title: Proportional value of interventions across pathways and layers of the biosecurity system
Division: NZ MPI BSFSRARA
2018–19: $45 000

Project ID: 180601 ❖AR
Project Title: Models for border inspection for pelleted seeds: how much assurance?
Division: NZ MPI
2018–19: $50 000

Last updated
13 Aug 2018

Building scientific capability $527 000

Project ID: 170713 ♦TK
(extension of 1607A)
Project Title: Value of Australia's biosecurity system
Division: Biosecurity Policy and Implementation
2018–19: $236 000

Project ID: 170714 ♦KS
(extension of 1607B)
Project Title: Health of Australia's biosecurity system
Division: Biosecurity Policy and Implementation
2018–19: $260 000

Project ID: 180702 ❖ SH
Project Title: CEBRA research: harnessing past and new work to improve uptake and impact of best practice risk analysis approaches in MPI
Division: NZ MPI
2018–19: $31 000

FUNDING
2018–19: $1 247 244

Data and information $149 904

Project ID: 170805 TK
Project Title: Optimisation of national resources for animal disease surveillance
Division: Biosecurity Animal
2018–19: $149 904

Key
AR – Andrew Robinson
SH – Susie Hester
TK – Tom Kompas
KS – Karen Schneider
❖ – NZ MPI project
♦ – Collaborative with NZ MPI

PROJECT SUMMARIES

Strengthening surveillance

170602: Increasing confidence in pre-border risk management

International trade in aquatic animal products is governed by the World Trade Organization's Agreement on the Application of Sanitary and Phytosanitary Measures, to which Australia is a signatory. The trade typically relies on certification undertaken by Competent Authorities (CAs) to certify that a product meets the importing requirements of a given country, including freedom from certain pests and diseases of concern to the importing country. For aquatic animals and aquatic animal goods, like ornamental finfish, salmon and prawns, the Department of Agriculture will only accept trade from countries with a CA it recognises and has approved. The department grants the more rigorous approved status to a CA—once an evaluation occurs—on the capacity for the agency to comply with Australia's import requirements.

The evaluation of a prospective CA by the department occurs only once, prior to the establishment of the approval. There is currently no requirement for random or routine auditing of CA procedures by Australia once the initial agreement has been established. Non-compliance with certification requirements may be discovered during document assessments, or through routine physical inspections at the Australian border. In some cases, however, there is no requirement for a physical inspection of CA-certified goods—goods will be released from biosecurity control based only on an assessment of the documentation.

In using CAs to manage its risk offshore, the department is delegating certification authority to a third party. Economic theory on incentives, in particular delegation theory, suggest the scope and effectiveness of this delegation would usually be governed by how well-aligned the interests of the department and CA are. Theory also suggests that the department needs to implement monitoring to ensure that the actual decisions being taken by a CA fall within the rules and guidelines that have been prescribed.

This project focuses on investigating the behaviour of CAs in undertaking their certification role and provides guidance on whether Australian border inspection policies should be modified in response. The analysis involves interviews with stakeholders, analysis of import inspection data and insights from economic theory. Two aquatic animal pathways are used in the analysis, but the methodology and findings are likely applicable across a range of other pathways.

170606: Developing models for the spread and management of national priority plant pests

The department is the major contributor of resources to eradication and containment activities and plays a coordinating role in early detection surveillance for national priority plant pests (NPPPs). Effective deployment of resources for early detection surveillance will pre-emptively lower Australia's potential liability for incursion costs.

Emergency responses to major pests consume significant resources which can be reduced by a more informed understanding of the relationship between pests, the incursion environment and surveillance information. Modelling can provide guidance to the Consultative Committee on Emergency Plant Pests (CCEPP), the National Management Group (NMG) and advisory groups on the appropriate course of action for response management, including technical feasibility and the cost–benefit of eradication or containment. Managing incursions of priority plant pests is often confounded by a poor understanding of the distribution of the pest. Surveillance activity tries to refine the potential distribution over time, but it can be difficult to understand the hidden incursion process in relation to presence and absence data, particularly for pests with broad host ranges, complex spread pathways and poor detectability. Custom-made models have been constructed in response to emergency plant pest incursions in the past, but the Australian animal disease (AADIS) model (Bradhurst et al. 2015), will provide the basis for a better maintained departmental system that will help prepare for high-priority pests, as well as being adaptable for use in responses to other pests.

This project will produce mechanistic and statistical models to support the management of NPPP incursions. Eradication and containment models will be based on plausible pest establishment and detection scenarios in operational settings.

Managing incursions requires that knowledge of pest ecology and epidemiology will work in conjunction with surveillance data to guide the appropriate zoning and implementation of control measures. Models will simulate the spread of incursions from potential establishment locations through natural and human-assisted spread. The capacity for surveillance data to delimit incursions with respect to control technologies will be determined through statistical modelling.

Year 1 saw significant changes to the AADIS software architecture. The model now operates in three distinct modes: livestock disease, vector-borne disease and plant pest. As suggested during the project workshop held in Canberra on 29 August 2017, an exotic fruit fly *(Bactrocera dorsalis)* was chosen for the initial case study. During year 2 of this project, control measures (detection, surveillance, movement restrictions, destruction and treatment) will be implemented as per Plant Health Australia's 2016 Australian emergency plant pest response plan (PLANTPLAN). The project will investigate the spatial representation of the host material over time in relation to incursions, including the availability of commercial, backyard and weed hosts. Model stability over different scales will be assessed and methods to address parameterisation will be documented.

The model will proceed with fruit fly trapping as a case study to identify control and trapping scenarios and their sensitivity to assumptions about dispersal and lure attractancy. Further development of habitat layers will be pursued in order to develop more realistic spread and control dynamics. Model sensitivities to assumptions surrounding the declaration of eradication will be explored.

170607: Developing scientifically robust risk maps for priority plant pests

The department plays a major role in surveying for the early detection of high-impact invasive plant pests. Surveillance for early detection of invasive plant pests is labour intensive and costly to maintain. Efficient allocation of increasingly scarce surveillance resources across all risk areas presents a significant challenge for the department. Compounding the issue of prioritising which pest species to target in early detection surveillance, little to no information is available about where, when and how a new pest species is likely to arrive and establish in Australia.

In order to determine where surveillance resources should be allocated to maximise early detection or confidence in pest freedom, it is imperative we have an understanding of how risk of pest establishment varies across space (Wintle et al. 2012; Hauser et al. 2009). Fundamentally, the risk that a pest arrives and establishes at a location is a function of three primary processes:

1. the pest's ability to arrive at a given location
2. the environmental suitability of that location
3. the presence of hosts and/or vectors at that location.

Several approaches (Dodd et al. 2016; Barry et al. 2016; Elith 2011; Václavík & Meentemeyer 2009; Work et al. 2005) exist to estimate each of these processes. However, previous CEBRA projects (e.g. 1402B and related paper Barry et al. 2016; 1302A and related paper Burgman et al. 2014) have highlighted that different methods can give very different results, likely as a consequence of making different assumptions and having differing data requirements (Guillera-Arroita et al. 2015).

These studies have also highlighted that there is no single best approach to estimating invasive species distributions (Barry et al. 2015). The combination of these uncertainties has made it difficult for decision makers to decide how best to estimate pest climate suitability, arrival rates, potential invasive pest distributions, and consequently, how to develop scientifically defensible maps of risk of establishment.

The primary objective of this three-year project is to develop a standardised approach for estimating risk maps that incorporate pest arrival rates, environmental suitability and the presence of hosts. Specifically, the project will develop practical guides (for example, decision trees) for deciding how best to estimate environmental suitability and arrival rates, in the face of varying data quantities and qualities, pest biology, and uncertainty about the most appropriate model-fitting approach. These practical guides will then permit a standardised approach for the development of scientifically defensible maps of risk of pest establishment.

The continuation of the project into its second year is critical for developing scientifically robust risk maps that can be readily applied to most plant pests. The second stage will focus on estimating the distribution of pathway-specific relative risk across Australia. Initial risk maps developed in stage 1 will then be refined by accounting for improved estimates of geographic risk and the incorporation of additional high-risk pathways of pest arrival.

Furthermore, underlying code used to create these risk maps will be updated and supplied to the department for incorporation into their IT systems.

It is imperative that stage 2 be conducted to ensure developed risk maps are fit for purpose:

1. Risk maps should meet scientific standards (the methods are transparent and reproducible).

2. Code developed can be readily implemented in the department's IT systems.

3. Risk maps can be created across the nation using best available data.

4. Risk maps can be used to inform optimal allocation of finite surveillance resources, pest freedom and pest spread.

170608: CBIS/CSP sensitivity analysis

The department's ability to implement new and existing inspection protocols pathways is often limited by a lack of understanding about characteristics of import supply chains that may increase or decrease biosecurity risks, compliance rates, and thus approach rates at the Australian border. Characteristics that may change biosecurity risks include whether offshore certification has taken place; the complexity of the product and the level and type of processing that has occurred; the length of journey; and the standards in the country of origin. In addition, aspects of the production environment offshore—such as whether a pest is known to be present in the growing area, and how it is managed on-farm —may also change the approach rate at the Australian border.

This project investigates how these diverse types of information could enhance the implementation of biosecurity inspection protocols at the Australian border, including further rollout of the Compliance-Based Intervention Scheme (CBIS) by the department.

170615: Assessing ant pathways to better inform site selection for ant surveillance

The National Invasive Ant Surveillance Programme (NIAS) detects 10–12 exotic ants per year at ports and targeted transitional facilities (devanning sites). With each incursion, the origin of the exotic ants that were detected is unknown, and it is impossible to trace the incursion. Due to the fact that the ants move from the containers to a food source by the time of sampling, there is generally no association of the ants with specific containers. Understanding the relative origin of ant incursions would better inform the risk around surveillance sites and help with selecting transitional facilities for future surveillance. There are thousands of transitional facilities clustered throughout the country and smart site selection is needed to target the risk associated with transitional facilities.

At present, risk variables, such as first port of origin and volume of containers; commodity type; and sites of previous detections of ants or other insects, are used to determine which transitional facilities are surveyed. There is no evidence, however, that these variables are important for predicting where ant incursions may occur, and consequently, whether they are important for site selection. It would be useful to know if these (and other) variables are key components for site selection, and to identify the etiology of ant arrivals to New Zealand to inform where ant surveillance can be targeted.

The main objective of this project is to develop a better understanding of the patterns of ant arrivals to New Zealand. The project aims to predict risk in relation to sites, and in particular, transitional facilities, where ants are more likely to arrive. The development of such risk profiles will enable scientifically defensible rationale to select sites for targeted surveillance within the NIAS.

The first year of the project has been spent collating and curating data in preparation for the second year, which is the modelling phase. An interim report was produced and provided to MPI (Veronica Herrera) at the end of May 2018. This report included a network diagram describing possible ant pathways into New Zealand, as well as preliminary analysis of some of the datasets collected. The preliminary analysis suggested that the data collected could be used to describe the changing patterns of ant arrivals into New Zealand over time.

170621: Proportional value of interventions across pathways and layers of the biosecurity system

This project is an extension of project 1606E: Scoping the value of performance of interventions across New Zealand's biosecurity system.

New Zealand's biosecurity system faces increasing pressure from significant increases in goods and passengers, changing pathways and types of goods. With this increasing pressure, all layers of the system need to work together, cost-effectively, to maximise the reduction of biosecurity risk to New Zealand under sharply constrained resources.

In order to increase the efficiency of biosecurity investment and to identify opportunities for substantial improvement, the Ministry for Primary Industries needs to determine the relative contribution of each layer towards biosecurity effectiveness. Presently, there is no agreed framework or process available to evaluate the comparative value of biosecurity activities implemented at intersecting sites across the biosecurity system matrix. Without knowledge on the likely effectiveness and costs of activities and control measures, risk management decisions on measures and allocation of resources at different nodes cannot be systematically evaluated.

This project seeks to further develop a decision-support framework that would significantly improve risk management decisions and resource allocation throughout the biosecurity system (from pre-border activities to pest management) by applying a systematic risk–return approach and evidence-based analysis. The project will focus on extending current work on a high-level framework and example case studies such as fruit flies and brown marmorated stink bug (BMSB), to provide a much more comprehensive tool to populate with data across all major pathways.

The project objectives are an extension to those provided for project 1606E:

1. Develop a fit for purpose pathway-based framework using the seven layers of New Zealand's biosecurity system that will allow risk management decisions to be made on a risk–return basis.
2. Provide specific performance outputs for specified pests, for example, fruit fly, BMSB, and selected pathways.

Comparative analyses will ultimately, after, first, the completion of this scoping project, second, appropriate generalisation of its outcomes, and third, implementation of its recommendations, achieve the following:

- illustrate the value of the current allocation of biosecurity activities and resources
- inform and justify reallocation of resources where needed
- provide evidence-based information for adjustment of existing measures at specific nodes in the biosecurity system matrix
- support communication of the holistic and interdependent nature of the biosecurity system to all stakeholders.

The first year of the study (2016–2017) initiated a framework through which MPI could summarize the actions of the biosecurity system against a pest.

The second year of the project (2017–2018):

- established that
    - o the simple framework advanced in the first year was unable to capture the complexities of the interactions of post-border investment choices
    - o often, pre-border activities did not fall neatly into the three pre-border layers
    - o the structure of the three pre-border categories implied a hierarchy that was unsupported by reference to the activities being undertaken
- trialled a two-stage approach whereby more detailed snapshots of pathways will be used to estimating the impacts of activities, and simpler representations (namely, pre-border, border and post-border) used as summary tools
- reviewed candidate bio-economic models to best represent the impacts of post-border investment
- developed a suitable representation of uncertainty
- developed a means of handling pest groups (such as timber pests) efficiently
- split the system across three main areas (pre-border, border and post-border) with four main pathways (craft, cargo, mail, passenger) overlaid with the seven groups of biosecurity risk assessment and management activities (anticipate, prevent, screen, prepare, direct, respond recover), as identified in CEBRA project 1607B: The health of the Australian biosecurity system.

Year 3 of the project (2018–2019) will:

- test and finalise the biological component (estimates of risk reduction across intervention activities of the system) of the risk decision-support tool by running the top twenty priority pests identified by MPI though the matrix
- identify opportunities for enhancements, automation or simplification including acquisition and use of MPI data and resources.

180601: Models for border inspection for pelleted seeds: how much assurance ?

New Zealand has a highly valued and internationally respected seed growing and seed export industry due to its disease-free status and the ability to provide additional growing seasons for Northern Hemisphere producers. The success of the industry is dependent on the ability to import seed of a wide variety of species and from different production areas. To meet current phytosanitary requirements, MPI has established processes and procedures for the documentation, sampling and testing of imported pelleted seeds for sowing to ensure that foreign seeds as contaminants are not incidentally present in consignments. The current sampling requirement to detect foreign seeds as contaminants requires a sample of 31 540 seeds per lot in order to achieve 95% confidence of detecting foreign seeds in lots that are contaminated at 0.01%. Samples are then analysed for identification of all seeds present in the sample by a seed analyst. Prior to being analysed, the seeds are required to have their pellet removed by soaking under hot water. These measures were implemented after the incursion of velvet leaf in pelleted seeds in 2016, therefore records of contaminants from pelleted seed lots are available.

The same intensity of inspection is carried out for each consignment within the pathway (a pathway is considered as a sequence of consignments of a specified product arriving from a specified supplier) regardless of the source, the processing history, the inspection history of the pathway, country of origin and so on. This inspection regime treats all consignments as equally risky, ignoring potentially valuable information, such as inspection history and pathway assurance measures through audits at the production site.

An alternative testing protocol is required to maximise the sustainability and growth of the New Zealand seed export industry, while minimising the biosecurity risks to New Zealand. Earlier CEBRA work that was designed to answer a similar question for importing small lots of seed (CEBRA 1606A) was hampered by a lack of information about the failure rates of laboratory-based seed tests. This project will involve the analysis of data from a pathway that is subjected to stringent onshore testing by MPI, namely pelleted seeds.

The purpose of this project is to assess whether using the available data differently, or using other kinds of data, in combination with some level of on-arrival inspection, will provide assurance comparable to that provided by the inspections that are prescribed by ISPM 31. This project will assess protocols that deviate from the current specifications (that is, 95% confidence to detect contaminated seed lots with prevalence 0.01% or greater) on a lot-by-lot basis, yet may provide sufficient assurance that risks are minimised within a pathway. The protocols need to be flexible enough to help facilitate the frequent import of different volumes of seeds, different species of seeds and seeds from different country of origin. Such protocols will be applicable to seed lots and may also be applicable to other commodities that require intervention. The new protocols will allow for the inclusion of other types of assurance, such as auditing in production sites.

Building scientific capability

170713: Value of Australia's biosecurity system

This project is an extension of project 1607A: Value of Australia's biosecurity system, for a third year to 30 June 2019.

Australia's biosecurity system provides a substantial benefit to the Australian community by managing the risks of pests and diseases entering, establishing and spreading, causing harm to human, animal and plant health, the environment and the economy. Australia also benefits from an effective biosecurity system by being better positioned to export high quality agricultural produce into premium international markets.

We know the system is inherently valuable but its value is difficult to quantify. This is because the system has a complex interplay of parts across supply chains, geographies, jurisdictions and stakeholders. Past attempts to value the biosecurity system have been based on ad hoc and qualitative statements of overall benefits or limited to specific cases, such as an estimate of the cost to Australia of an incursion of foot-and-mouth disease and other major invasive pests and diseases.

The research will serve multiple purposes for the department such as contributing to an assessment of the health of the biosecurity system through annual reporting requirements; providing evidence and context in conversations with governments from all jurisdictions, industry and the community; and informing and contributing to a national biosecurity strategy, Intergovernmental Agreement on Biosecurity (IGAB) and the National Environmental Biosecurity Response Agreement (NEBRA) reviews.

The overall objective of the multi-year project is to:

1. set out and design the methods that are needed to measure the value of the biosecurity system as a whole, and its various components

2. to further develop and adapt the preferred approach for valuation and the aggregation of values specific to the Australian context

3. work towards providing component measures and an aggregate value measure of the biosecurity system across different biosecurity measures and threats, taking into account different desired outcomes.

The outcomes sought from this project are as follows:

1. estimate a defensible value of the biosecurity system and indicate best ways to maximise rates of return with value-added measures for biosecurity

2. understand where the components that make up that value are generated across the biosecurity system, and where net returns may be highest

3. create a benchmark value for comparison with future value estimates.

Phase 1 of the project (2016–2017)

Delivered a comprehensive review of the biosecurity economics literature, and identified suitable methods, measures and indicators of the types of value generated by biosecurity interventions. Phase 1 concluded with the delivery of a report that outlined a framework for estimating the value of Australia's biosecurity system through a multi-year project.

Phase 2 of the project (2017–2018)

Reviewed and standardised existing estimates of value, and included any new measures of market values provided by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES); extended these estimates to include non-market values, using 'benefit transfer' measures, and the best procedure for undertaking non-market valuation generally; and updated/refined methods to properly aggregate measures of value up to the system scale.

Phase 3 of this project (2018–2019)

Will continue to augment the existing market and non-market value estimates, where required; aggregate these values, where appropriate; and, moreover, develop a global framework for capturing the measure of value for the system as a whole, in a fully integrated setting. The proposal is to develop a Markov chain Monte Carlo stochastic approximation approach that simulates the arrival and potential spread of pests throughout Australia and thus to measure values with no biosecurity system in place (the counterfactual) and with biosecurity measures (border and post-border) operating.

170714: Health of Australia's biosecurity system

This project is an extension of project 1607B: Health of Australia's biosecurity system, for a third year to 30 June 2019.

The objectives of the department include maintaining and enhancing Australia's favourable animal and plant health status. This objective is underpinned by evidence-based policy, delivered through Australia's national biosecurity system.

The national biosecurity system is a combination of interventions that help Australia anticipate, prevent, screen, prepare for, detect, respond to, and recover from, or adapt to, biosecurity risks—this includes activity pre-border, at the border and within Australian territory, and work to support Australia's access to export markets.

The performance or health of the biosecurity system is a measure of the system's capacity to deliver its key functions and activities:

- biosecurity intelligence that provides timely knowledge of the pest and disease threats approaching Australia (anticipate)
- pre-border and border controls to prevent, or reduce to an acceptable level, the likelihood that pests and diseases are present on the goods and conveyances that approach and enter Australia (prevent)
- border screening to detect potential incursions of pests and diseases (screen)
- policy, planning and tools that facilitate responses to biosecurity incursions (prepare)
- post-border surveillance to detect incursions of pests and diseases (detect)
- responses to pest and disease incursions that minimise their impacts (respond)
- recovery after successful eradication programs or adaptation to established pests and diseases through activities that minimise costs and support continued market access (recover or adapt).

The national biosecurity system should be capable of delivering these activities in an effective, efficient, robust, resilient and sustainable manner.

The department is seeking a framework and methodology to measure and report on the health, or performance, of the Australian biosecurity system. This should build on existing capability and develop new methods that can be used repeatedly to articulate the health of the biosecurity system at the national level, against agreed performance criteria.

The need for this project arises because the department does not currently have a system for articulating the performance of the biosecurity system on a national level that captures all elements of the system and all participants in the system; that articulates relevant attributes of system performance and establishes qualitative and quantitative measures of performance; that can be repeated at agreed intervals; and that can be used to support decision-making, particularly related to the quantity and allocation of investments in the biosecurity system.

The department currently relies on qualitative pathway-specific risk analyses and reviews to assess and, if necessary, address potential unacceptable exposure to risk. Some work has been done collaboratively by government jurisdictions under the IGAB to evaluate the effectiveness of resource allocations for surveillance and emergency response activities. However, the department does not currently have a means of estimating the health of the national biosecurity system as a whole against appropriate performance criteria. This is a serious gap that limits the capacity of the department to evaluate the adequacy of investment across the biosecurity system.

The primary objective of the project is to develop a framework and methodology to measure and report on the health, or performance, of the Australian biosecurity system, that can be repeated at regular intervals. This should capture all elements of the biosecurity system and all participants in the system; articulate relevant attributes of system performance; and establish qualitative and quantitative measures of performance and associated performance indicators.

Key outputs from the project include the following:

- a comprehensive review of the performance evaluation literature relevant to the biosecurity system, including performance evaluation of complex systems in the public sector in Australia and internationally (delivered, phase 1)
- a detailed description of the activities undertaken in the biosecurity system using a program logic approach, their intended outputs and their direct, system level and external outcomes (delivered, phase 1)
- a list and definition of the attributes of biosecurity system health against which the performance of the biosecurity system's outputs and outcomes could be assessed (delivered, phase 1)
- a list of the qualitative and quantitative measures of performance and associated performance indicators for outputs and outcomes for each element of the biosecurity system (in progress, phase 2 and 3)
- case studies on each element of the biosecurity system that identify how the framework will be implemented for this element (in progress, phase 2 and 3)
- an assessment of data sources for each performance indicator and identification of gaps in data and information needed as input to metrics or measures, in particular data that are currently not collected but would be of benefit for determining the health of the biosecurity system or individual elements of the system (in progress, phase 2 and 3).

180702: CEBRA research: harnessing past and new work to improve uptake and impact of best practise risk analysis approaches in MPI

MPI has not yet fully capitalised on existing research outputs from the Australian Centre of Excellence for Risk Analysis (ACERA) and CEBRA's work with the department completed over the past eight years. There is scope to use methodologies developed in the research and outputs from earlier projects to solve additional biosecurity problems. Currently, however, access to methodologies used in projects, adoption of research findings, and the use of these findings in new projects is ad hoc, and depends on the corporate knowledge of the project team. Such an approach may result in missed opportunities and duplication of research. Access for MPI staff to research projects, their outcomes and impacts, would have many benefits:

- assist knowledge management over time, regardless of staff changes
- provide a system to record adoption of impacts, thus allowing an understanding of return on investment to CEBRA projects
- provide a knowledge base from which new projects could be developed.

This project will assemble the approaches, methodologies, subject areas, and best-practice conclusions developed in CEBRA research projects over many years, and highlight and facilitate their application to current problems faced by MPI.

Phase 1 of this project (2018–2019) is around knowledge management, and will involve several steps:

- interviewing a range of MPI staff in order to assess their potential use of the database, past use and knowledge of CEBRA research, and appropriate methods to encourage future use of the database
- assembling the CEBRA knowledge resource, including an assessment of the different types of information that should be captured and stored, and how this storage process can become business as usual (this may include suggestions for how automated reminders could be managed for CEBRA and MPI researchers to upload new outputs and new adoption activities)
- making staff aware of the research outputs and to encourage the distribution and use of this knowledge
- capturing information about attempts to access CEBRA research outputs.

Data and information

170805: Optimisation of national resources for animal disease surveillance

Australia relies heavily on animal health surveillance both to protect the health and productivity of its livestock and other animal industries, protect human and wildlife health and to support trade and market access. In the current world trade environment, the ability to demonstrate freedom from disease is crucial for maintaining export trade in livestock products and for re-establishing trade as soon as possible after an outbreak has occurred. There is growing recognition by Australia's national and jurisdictional governments and agricultural industries that Australia needs to strengthen its surveillance arrangements to be able to mitigate biosecurity threats while continuing to facilitate and enhance trade (East et al. 2016). The reliability of Australia's surveillance system has been questioned, largely owing to reductions in expenditure on agriculture and a reduction in the veterinary services in rural areas (Nairn et al. 1996; Frawley 2003; Matthews 2011; OIE 2015).

Resources for surveillance are finite and therefore need to be allocated optimally. The IGAB promotes a risk-based approach to biosecurity, prioritising the allocation of resources to the areas of greatest return. Current surveillance activities include:

- general surveillance at the jurisdictional level, that is, detection, investigation and reporting of disease syndromes (this is relied upon to detect most outbreaks of livestock disease)
- active and targeted national surveillance programs, such as the National Transmissible Spongiform Encephalopathy Surveillance Program and the National Arbovirus Monitoring Program
- various regional surveillance projects that have been developed independently, operate in one or only a few jurisdictions and contribute to the national surveillance effort (e.g. knackery surveillance in Victoria).

Despite considerable investment by Commonwealth and jurisdictional governments, there is currently no national agreement or consistency around prioritisation, rationalisation or optimisation of activities for onshore (post-border) animal disease surveillance. Efficient and defensible allocation of increasingly scarce surveillance resources across all risk areas presents a significant challenge for the department and our jurisdictional colleagues.

This project aims to provide a mechanism that enables a rational, consistent and optimal allocation of national resources for terrestrial animal disease surveillance.

The projects outcomes are as follows:

- CEBRA will develop and refine methods for which finite animal disease surveillance resources can be allocated at the national and jurisdictional level, based on robust, agreed processes, ultimately leading to a national surveillance portfolio that can efficiently and effectively detect and monitor animal disease threats. Victoria is taken as a case study of this approach, and as a leading example of how the project may be extended to other jurisdictions.

- Stakeholders will have increased confidence in Australia's animal health status.

During year 1 (stage 1 and 2, 2017–18) of this project, jurisdictional agency agreed on a path forward for surveillance prioritisation, which now clearly requires the use of structured decision-making, existing spread modelling and expert elicitation methods. It was determined that the focus for the optimal surveillance modelling—determining value-added and expenditures across the portfolio of pests—will focus on foot-and-mouth disease, classical swine flu, avian influenza (HPAI), and bluetongue. The locational focus remains Victoria, although with a developed model context that can be used more generally. There may be some substitutions for pests depending on model constraints and data availability.

In conjunction with key stakeholders—including Biosecurity Animal Division, Northern Australia Quarantine Strategy (NAQS) and jurisdictional chief veterinary officers and surveillance managers—is in the stage of finalising the suggested approach, methodologies and details of the case study. In particular, this phase of the project is developing the suggested approach for a computer-based model used in year 2 to evaluate the efficacy of different post-border surveillance scenarios and methodologies to detect incursions. The project team has determined that a combination of model platforms between AADIS and optimisation techniques standard at CEBRA will be the preferred approach.

During year 2 (stage 3, 2018–19) the project aims to produce useful prioritisation and optimisation tools the methodology should draw on, and extend, namely, epidemiological and economic models (portfolio theory and cost–benefit analysis) such as those developed in previous CEBRA projects. These methods will then be applied and extended to other jurisdictions. The preferred model approach will be a combination of two elements, with AADIS informing the optimisation project:

- potentially extending AADIS to account for spread and control characteristics of other pests and diseases in the case study

- using dynamic programming methods and portfolio allocation methods developed in previous CEBRA projects on animal disease and optimal surveillance.

The emphasis will be on dynamic programming methods, informed by AADIS modelling.

CONTINUING PROJECTS

The following projects were approved in the 2017–2018 work plan, and were approved to continue in 2018–2019.

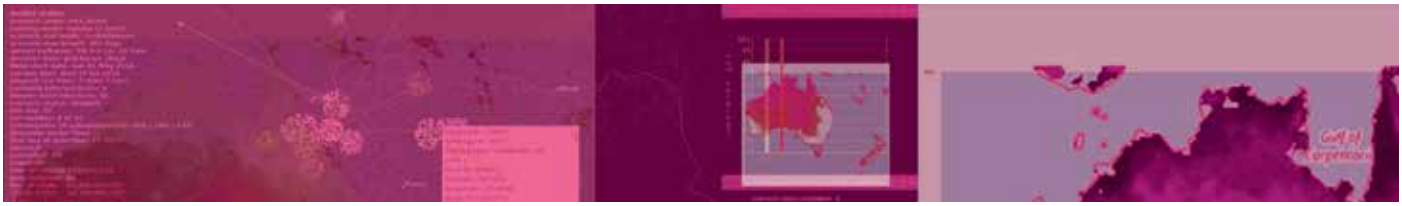
- 170602: Increasing confidence in pre-border risk management
- 170606: Developing models for the spread and management of national priority plant pests
- 170607: Developing scientifically robust risk maps for priority plant pests
- 170608: CBIS/CSP sensitivity analysis
- 170615: Assessing ant pathways to better inform site selection for ant surveillance
- 170821: Proportional value of interventions across pathways and layers of the biosecurity system (extension of 1606E)
- 170713: Value of Australia's biosecurity system (extension of 1607A)
- 170714: Health of Australia's biosecurity system (extension of 1607B)
- 170805: Optimisation of national resources for animal disease surveillance

DELIVERABLES AND MILESTONES ACHIEVED

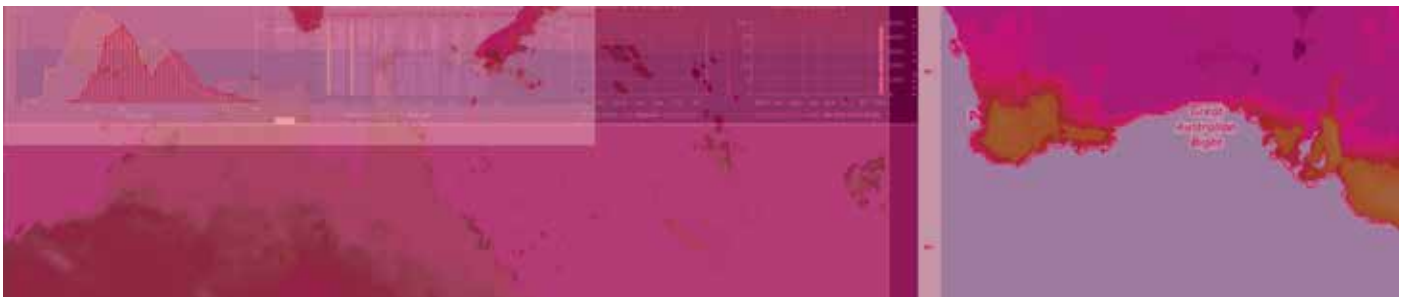
The following table lists the key project outputs. It also details which outputs will be submitted to the Commonwealth for endorsement in accordance with clause 3.9 of the funding agreement.

Table 2: Research outputs

Project	ID	Output	Milestone Date	For Endorsement	Status
Strengthening surveillance					
170602	1	Confirmation of plan for stage 2 of the project, including analysis, pathways and so on	Jun 2019	N	Complete
	2	Final report	Jun 2019	Y	In progress
170606	1	The NPPP detection and control workshop: • review of existing AADIS control mechanisms for extensibility to NPPP • identification of NPPP-specific control measures to be implemented • identification of data and parameterisation required for the AADIS NPPP control mechanisms • formulation of NPPP detection and control case studies	Jul 2018	N	Complete
	2	Workshop report provided to the department	Aug 2018	N	Complete
	3	Data and parameterisation needed for NPPP control case studies provided by the department	Sep 2018	N	Complete
	4	Interim software delivery	Feb 2019	N	Complete
	5	Draft report provided to department project leaders for comment	May 2019	N	In progress
	6	Year 2 final report and software delivery	Jun 2019	Y	In progress
170607	1	Meeting with department project leaders	Aug 2018	N	Complete
	2	The department to review data they (or state counterparts) currently collect which can be used to inform the geographic risk associated with major plant pest pathways	Dec 2018	N	Terminated
	3	Review literature for current approaches and data sources for estimating pathway-specific geographic risk	Dec 2018	N	Complete
	4	Create national maps of relative risk for identified pathways and provide to the department for review	Feb 2019	N	Complete
	5	Update risk map framework and code to reflect new pathways and data sources collated	Apr 2019	N	Complete
	6	Refine risk maps developed in stage 1 (or create risk maps for new pests)	May 2019	N	Complete
	7	Draft final report	Jul 2019	N	Complete
	8	Final report	Aug 2019	Y	In progress



Project	ID	Output	Milestone Date	For Endorsement	Status
Strengthening surveillance					
170608	1	Identify pathways to use for pilot study	Jul 2018	Y	Complete
	2	Refine and apply model to pathways	Nov 2018	N	In progress
	3	Preliminary guidelines for CSP parameter selection	Jan 2019	N	Complete
	4	Final guidelines	Jun 2019	N	In progress
170615	1	Preliminary comparison of analytical strategies	Dec 2018	N	Complete
	2	Workshop to discuss analytical strategies	Feb 2019	N	Terminated
	3	Final development of chosen analytical strategy	Feb 2019	N	Complete
	4	Draft framework for targeted surveillance	Apr 2019	N	Complete
	5	Final report	May 2019	Y	Complete
170621	1	Priority pests identified	Sep 2018	N	Complete
	2	Initial four studies complete	Jan 2019	N	Terminated
	3	Balance of twenty studies	Jun 2019	Y	In progress
180601	1	Literature review	Dec 2018	N	Complete
	2	Design of simulation studies	Dec 2018	N	Complete
	3	Execution of simulation studies	Feb 2019	N	Complete
	4	Draft report with case studies	Apr 2019	N	Complete
	5	Final report with case studies	Jun 2019	Y	In progress



Project	ID	Output	Milestone Date	For Endorsement	Status
Building scientific capabilities					
170713	1	Project start and planning meeting	Aug 2018	N	Complete
	2	Meeting with ABARES and the department (risk–return resource allocation team) on planned work and agreed deliverables for this phase of the project	Sep 2018	N	Complete
	3	Work on the Markov chain Monte Carlo stochastic approximation (Markov SAA) and computable general equilibrium modelling to determine the value of the biosecurity system	May 2019	N	Complete
	4	Brief interim progress report on additional and aggregate value measures and the Markov SAA approach	Feb 2019	N	Complete
	5	Draft final report	May 2019	N	In progress
	6	Final report	Jun 2019	Y	In progress
170714	1	Workshop on case studies 1 (anticipate) and 2 (prevent)	Sep 2018	N	Complete
	2	Report on case studies 1 (anticipate) and 2 (prevent)	Dec 2018	N	Complete
	3	Workshop on case study 3 (screen)	Feb 2019	N	Complete
	4	Report on case study 3	Apr 2019	N	Complete
	5	Final report	Jun 2019	Y	In progress
180702	1	Interview questions completed	May 2019	N	Complete
	2	Interviews with MPI staff	Jun 2019	N	Complete
	3	System design	Aug 2019	N	In progress
	4	System available for use and evaluation	Oct 2019	N	In progress

Project	ID	Output	Milestone Date	For Endorsement	Status
Data and information					
170805	1	Construction, calibration and testing of the portfolio allocation model	Jan 2019	N	Complete
	2	Workshop presentation of main results, evaluation and refinement	Feb 2019	N	Complete
	3	Outline and proposal for extension of the portfolio allocation model to more jurisdictions and potentially to additional diseases and pests	Mar 2019	N	Complete
	10	Draft final report	Apr 2019	N	In progress
	11	Final report	Jun 2019	Y	In progress

RESEARCH AND DEVELOP RISK METHODS

IMPACT AND ADOPTION ACTIVITIES

CEBRA plays an important role in supporting biosecurity risk management. Our research tackles challenging real-world questions, providing scientific backing for biosecurity practice and strategic decision-making.

Our risk analysts employ techniques such as intelligence gathering, data mining, cost–benefit analysis and spatial analysis. Using our expertise, we investigate data and develop associated methods, protocols and tools.

The aim is to ensure that CEBRA research outcomes provide knowledge about—and are effectively integrated into—the biosecurity system. Adoption impact has been reported on several projects.

1405C: Torres Strait risk and resource allocation project

The Torres Strait provides a range of challenges to biosecurity management arising from its close proximity to countries with differing pest, weed and disease status to Australia and movement pathways unique to the region. Risk-based decisions supporting effective biosecurity strategies and related resource allocations are challenged by limited availability of baseline risk data across a number of prevailing pathways, particularly small vessel movements not subject to state or Commonwealth reporting requirements.

In 2012, the Australian National Audit Office (ANAO) review of the Northern Australia Quarantine Strategy recommended that the department establish improved risk baselines for Torres Strait movements and enhance access to other meaningful data supporting risk-based decisions and performance measures for biosecurity regulation in the Torres Strait.

The Torres Strait risk and resource allocation project was developed to support biosecurity decision-making through:

- evaluating the relative risk and consequences of high-impact pest, weed and disease occurrences accounting for prevailing movement pathways and biosecurity intervention approaches in the Torres Strait
- developing decision-support models for optimal resource allocations to biosecurity strategies aligned to differing risk and budget scenarios
- establishing improved decision-support tools and baseline risk information for data poor pathways in Torres Strait consistent with ANAO recommendations.

Outputs and key insights

The evaluation of risks and consequences of high impact pests, weeds and diseases was conducted by Tom Kompas, CEBRA, and Daniel Spring, Australian Centre for Biosecurity and Environmental Economics (ACBEE), in consultation with peers within the CEBRA network.

Spatial-economic data models were applied to three case studies of invasive species of critical concern (papaya fruit fly, citrus canker and rabies) to prevailing risk pathways in the Torres Strait, the location and value of vulnerable agricultural production areas and communities and estimated impacts arising from incursion events.

Research findings were presented in the report 'Baseline consequence measures for the Torres Strait Islands pathway to Queensland: papaya fruit Fly, citrus canker and rabies' and broadly support the priority focus on these risks within the department's current regulation approaches. The research outcomes also provide models to inform future cost–benefit analyses for differing risk management approaches for the nominated species over time.

Models for optimal resource allocations to biosecurity were developed by Tom Kompas, Daniel Spring, Long Chu (ACBEE) and Pham Van Ha (ACBEE), in consultation with peers within the CEBRA network. Research outputs included models for allocating a biosecurity budget across different invasive species and/or different locations occupied by a single species and different biosecurity measures (prevention, active surveillance for early detection, containment and eradication).

Research findings were presented in the report 'Budgeting and portfolio allocation for biosecurity measures' and include case studies applying the resourcing models to four priority invasive pests and diseases (red imported fire ant, foot-and-mouth disease, papaya fruit fly and hawkweed). The research outcomes provide useful assessment models based on objective formulas to inform strategic biosecurity investments across the spectrum of prevention, active surveillance and eradication and control accounting for variable risk and budget scenarios. The models can be adapted to differing species, pending availability of required data inputs for effective operation of the formulas.

Research findings confirm the relative value of the department's investments in prevention measures for exotic fruit fly species, with increasing benefits arising from investments in active surveillance and prevention for the other evaluated species to an optimal total investment of $26 million (2012 values).
CEBRA evaluations of existing regulation data, availability of risk intelligence information, and the Torres Strait operating environment informed the development of a Bayesian network as the recommended tool to help establish improved risk baselines and support risk-based intervention strategies for uncertain and data-poor pathways.

CEBRA engaged Owen Woodberry, a specialist developer and statistical modeller in Bayesian networks, to deliver the requested decision-support tool, accounting for known variables in the Torres Strait pathways.

Expert elicitation workshops were held with community representatives, departmental staff and other agencies operating in the Torres Strait to establish baseline risk data applying the Bayesian tool with a priority focus on high-risk small vessel movements.

Findings of the elicitation workshops and application of the Bayesian tool to date have contributed to improved risk baseline data aligned to the ANAO recommendations, in particular, in relation to seasonal variations, high-risk movement corridors and volumes of vessel traffic considered in resourcing and Torres Strait biosecurity surveillance and regulation approaches.

Full realisation of the tool's decision-support capability is contingent on further data inputs identified through the project and ongoing access to system operators skilled in Bayesian methodologies. The department is building upon the foundational decision-support capability delivered by the project through a range of improved data capture and analytics measures arising from the white papers. Key initiatives to which the project outputs have contributed or informed include:

- design parameters for the Torres Strait Information System, that is, improved system for data capture and reporting of codified biosecurity regulation data
- empirical data collection on small vessel movements through the Torres Strait using innovative underwater surveillance technologies (addressing baseline data gaps identified through the project)
- improved data analytics capability in Bayesian and other methodologies through the biosecurity integrated information and analytics measure..

170820: Biosecurity response decision-support framework

The overarching purpose of this project is to improve and strengthen MPI's decision-making around new pest or disease incursion. The key area for improvement identified during the project was staff capability and capacity to understand and undertake non-market valuation. In the response context, this lack of capability means environmental impact of pests and diseases are undervalued in cost–benefit analyses, and inefficient resource allocation results.

Outputs and key insights

In order to understand current decision-making in the time-critical response context and recommend improvements, the review team consulted with MPI staff, undertook data analysis and reviewed relevant literature and tools.

This process led to the development of non-market valuation (NMV) guidance (Tait & Rutherford, 2018 [1]) and an associated 'benefit transfer tool'. The latter is an excel-based tool that allows MPI staff to undertake a simple NMV in a short time period (1–2 weeks). It effectively allows staff to screen the relative magnitude of environmental impacts. These may then be included in cost–benefit analyses and are useful in making recommendation about outsourcing a more detailed NMV.

Key insights included:

- Staff in the MPI response team are capable of undertaking, and willing to undertake, simple NMV (using benefits transfer).
- Staff in the MPI response team are now aware that a more detailed NMV may be undertaken in 5–6 weeks. The assumption had been that detailed NMVs would take too long to be considered possible in the time-critical response context.

The project has improved knowledge about NMV techniques, when they should be applied, by whom, and appropriate time frames for completion. This will allow more informed and assertive negotiations with outside providers of tailored NMVs. The MPI response team has had significant interaction with their counterparts in the Department of Conservation (DOC), both during the project and subsequent to its completion. MPI staff are keeping DOC updated on NMV methods, and while there are differences of opinion in appropriateness of methods, there is scope for collaboration with NMV in the future, which should benefit the environment and community in general.

Use of the excel-based benefits transfer tool has been underway for six months. Other recommendations will hopefully be implemented, once the final report has been received. These include recommendations related to data collection, embedding economists within response teams and undertaking primary (pre-emptive) NMV studies.

To encourage adoption and implementation, continued support of staff in their use of the benefits transfer tool should be championed by response team managers. The author of the tool and guidelines, Associate Professor Peter Tait, remains available to assist staff in using the tool and guidelines. Once the report is accepted in full, MPI will look to identify opportunities for research that enables us to utilise NMV in our responses.

Where to from here

In the future, staff awareness of NMV tools and methods will continue to be improved. Use of benefit transfer tool will be encouraged. Use of the tool may be challenging when new staff join the response team, and without economists on the team. A solution would be a regular recap on use of the tool at meetings. Peter Tait, the author of the tool has offered his ongoing support in this regard. Susie Hester has done the same.

[1] Tait, P and Rutherford, P (2018) *Non-market valuation of environmental impacts for biosecurity incursion cost-benefit analysis: a guidance manual for public policy.* ***Agribusiness and Economics Research Unit, Lincoln University***

170608: CBIS/CSP sensitivity analysis

CBIS is an automated tool for targeting the frequency of border inspections; however, its deployment has been somewhat limited to date (33 commodity groups since implementation in 2013), due to system restrictions. A broader application of CBIS on a range of import pathways will help free up border inspection resources for higher risk campaigns.

There is an increased need for adopting risk-based intervention to support new approaches to verification where we recognise activities in the production and trading system that contribute to managing phytosanitary risks.

The project sought to develop a decision-support tool to make it easier for the Plant Division to choose the most suitable CBIS rule parameters—the qualification number and risk-based inspection rate—for a given pathway. The decision-support tool could then be used to translate a statistical problem into a risk management setting.

The tools developed as part of this project can inform pathway management for which either inspection history exists, or little to no inspection history exists. While the Plant Division can commission ABARES to conduct statistical analyses on import pathway inspection data using tools developed in an earlier CEBRA project, the tool developed in this project allows Plant Division staff to interactively explore and assess alternative inspection strategy parameter combinations that may suit.

Alternatively, Plant Division officers can use the spreadsheet-based tool to develop recommendations based on understanding the potential consequences of pest leakage rates, which in turn is informed by science, and the trade-offs associated with alternative rule parameter choices.

Outputs and key insights

This project had two lines of inquiry:

1. analysing sawn timber pathway data to detect patterns of hitchhiker contamination

2. developing a decision-support spreadsheet tool that contextualises CSP parameter choices and illustrates the trade-offs associated with different parameter choices.

The decision-support spreadsheet tool was designed to provide a visual representation to 'what if' scenario testing to show the effects on leakage on a given pathway. There was also a requirement to estimate the percentage of inspections saved and the rate of post-intervention noncompliance rate. Officers are required to answer up to four questions on failure definitions, maximum leakage thresholds and CSP modes.

Probabilistic methods can be used to model the trade-offs associated with different CSP parameter combinations. Graphical tools can then be used to illustrate these trade-offs and develop recommendations, making the interpretation of potential parameter combinations tractable for pathway managers. Where pathway data are available, these tools can be used to complement Plant Import Operations (PIO) and ABARES's statistical analysis of potential pathways and allow pathway managers to engage more productively with ABARES.

The project found that timber pathway data analysis was hampered because the data arising from the inspection of timber consignments could not be interpreted as representing the whole timber pathway. A statistically justified timber analysis would need representative sampling and data collection methods to analyse for hitchhiker trends.

Due to the limitations of the inspection data available on the timber pathway, PIO experimented with the decision-support tool developed through the project to determine a suitable sampling protocol for timber imports from Canada (a country with most complete data). The pathway can then be monitored and as quality feedback data is obtained the prediction of the sampling tool can be reviewed.

Where to from here

Further testing of the decision-support tool is being undertaken by Plant Division:

- The cut flower team is looking into a sampling protocol to verify offshore devitalisation treatment and has used this tool as a basis for the design. There is now also interest to use the tool to design a sampling protocol to verify offshore pathogen testing for the nursery stock pathway.

- In the short term, the tool will be used in parallel to the existing methodology that PIO use when assessing suitable plant commodities for CBIS. This will allow time to test the boundaries and provide confidence to PIO that the decision tool can be relied on. The tool will then be considered for incorporation into the CBIS assessment methodology to become routine but also available to staff as a stand-alone to use as preliminary decision guidance.

There may be a need to draw on advice and evidence from other policy areas to help inform Plant Division's ability to quantify the bounds on the potential monetary values associated with leakage. The decision-support tool may be of interest to other areas across the department who are also interested in using CBIS to manage biosecurity.

Intelligence tools for regulated goods traded via ecommerce goods traded via ecommerce

This project has been superseded by capability development initiatives underway within New Zealand MPI, including the development of a data and analytics function. The ministry is in the process of finalising a tender to develop a platform that will extend beyond 'web crawling' for information. It will integrate both external and internal data, utilise machine learning (such as pattern recognition) to undertake data analysis, and deposit this analysis into a repository so that a range of analytics can be applied.

GRADUATE STUDENTS

CEBRA continues to make substantial investments in postgraduate research training. Our PhD students research and develop specialist techniques to tackle real-world problems, building biosecurity risk analysis capacity and capability in Australia and around the world.

Table 3: Current (2018–2019) PhD students

Student	Title	Supervisor
Current PhD Students		
Thiripura Vino	Human mobility models with imperfect data	Associate Professor Andrew Robinson
Nayomi Attanyake	Efficient estimation of hazard cut-points for risk-based fleet management	Associate Professor Andrew Robinson
Gayan Dharmarathne	Exploring the statistical aspects of expert-elicited experiments	Associate Professor Andrew Robinson

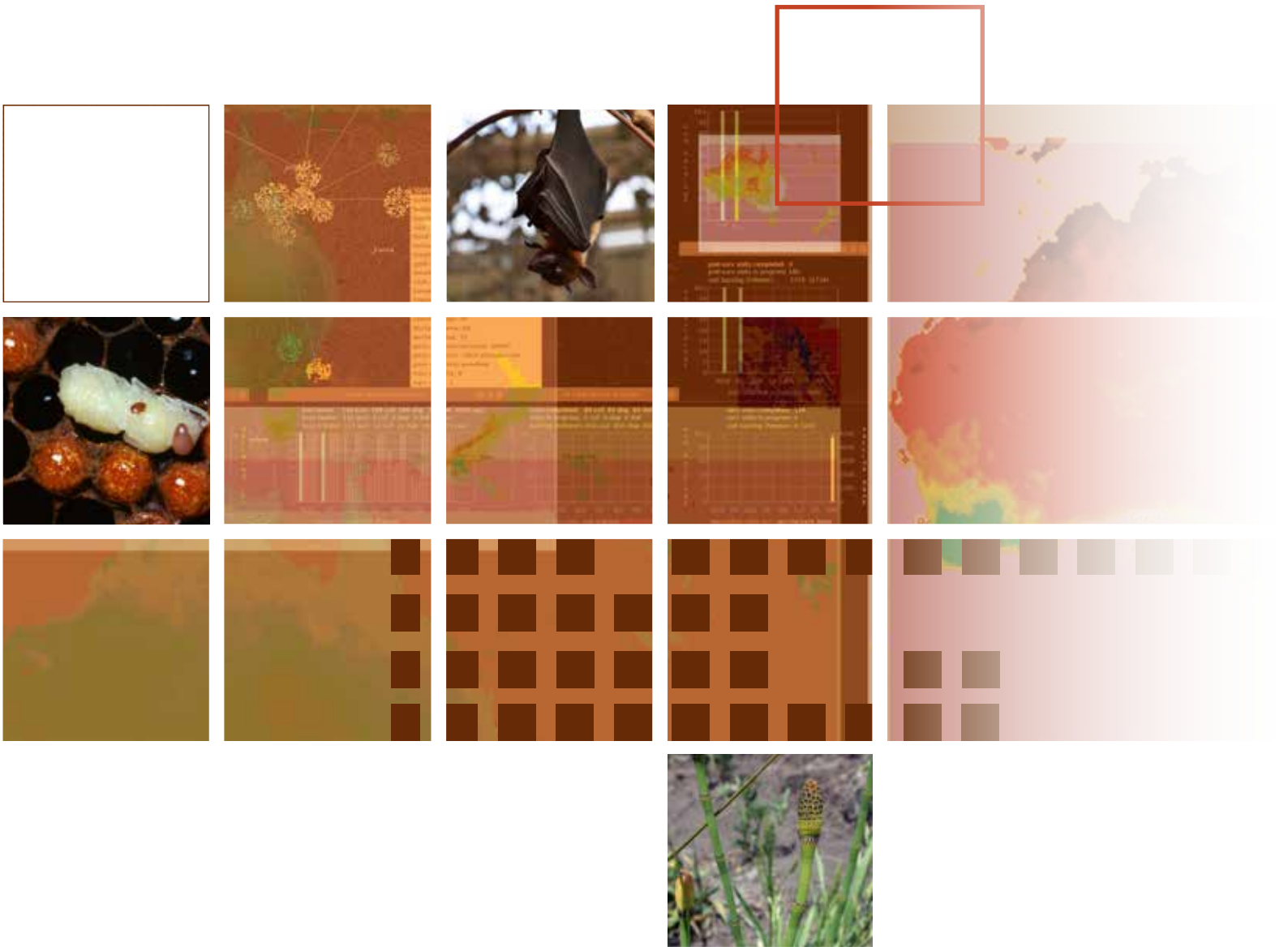
INSTITUTIONAL CONTRACTS AND CONSULTANCIES

CEBRA conducts robust scientific analysis and provides expert advice to a range of biosecurity stakeholders. Here are the institutional contracts and consultancies we have been awarded, relevant to the 2018–2019 financial year.

Table 4: Institutional contracts and consultancies

Client	Year	Project	Amount	Investigators
AgResearch Limited (NZ)	2019	Tourism, biosecurity and pathways into New Zealand: identifying risk and mitigation strategies	NZ$25 000	Associate Professor Andrew Robinson
Plant Health Australia	2019	Examine arrangements for the ongoing maintenance and verification of pest absence and/or area freedom status	A$19 795	Associate Professor Andrew Robinson Dr James Camac Dr Jason Whyte
Department of Agriculture	2019	Study comparing different Delphi approaches	A$27 271	Associate Professor Andrew Robinson Dr Anca Hanea
NSW Environment Protection Authority	2019	Chemical risk anticipation tool validation	A$41 200	Associate Professor Andrew Robinson Dr Jason Whyte
Cawthron Institute Trust Board	2018–2019	Aquatic Health Research Programme	A$66 642	Associate Professor Andrew Robinson Dr Anca Hanea Dr James Camac
NSW Department of Industry	2018–2019	Biosecurity food safety risk management system	A$150 000	Professor Tom Kompas Associate Professor Andrew Robinson Dr Aaron Dodd Dr Terry Walshe Dr Libby Rumpff
Department of Agriculture	2018–2019	Sampling of seeds imported for the purposes of sowing	A$100 000	Associate Professor Andrew Robinson
Australian Research Council	2016–2018	DP160100745 Maximising the benefits of emerging technologies for ecological survey	A$350 600	Associate Professor Andrew Robinson Adjunct Professor Andrew (Sandy) Liebhold Dr Joslin Moore Dr Aaron Dodd
Australian Research Council	2017–2019	DP170104795 Predicting the ecological and economic outcomes of trade	A$588 500	Professor Brendan Wintle Professor Tom Kompas Professor Mark Burgman

DOCUMENT AND COMMUNICATE FINDINGS



PUBLICATIONS

At CEBRA, we collaborate with researchers across many disciplines to apply and develop scientific methods. Our research is published in a range of peer-reviewed journals and other publications. For a full list of publications, please visit **www.cebra.unimelb.edu.au/engage/journal-articles.**

Table 5: CEBRA publications summary

Calendar year	Total publications	Total citations	Average citations	Average InCites impact factor	CEBRA project–specific publications
2018	26	108	4.15	3.72	8
2017	38	474	12.47	3.37	14
2016	29	525	18.10	3.73	8
2015	29	921	31.76	5.44	12
2014	16	604	37.75	5.75	3
2013	26	4389	168.81	5.45	11

CEBRA Publications with ISI Impact Factor and Citations

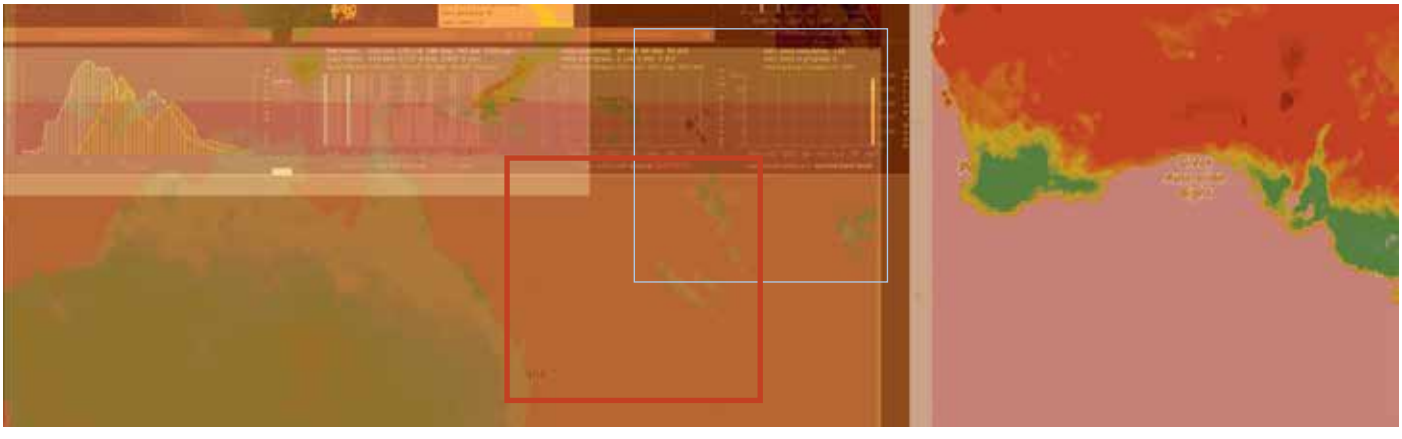
Table 6: CEBRA publications with InCites impact factor and citations as at 01/07/2019

	InCites impact factor 2018	No. of citations as at 01/07/19
IN PRESS/EARLY VIEW		
Bradhurst, R, Garner, MG, East, I, Death, C, Dodd, A & Kompas, T (provisionally accepted) *Management strategies for vaccinated animals after an outbreak of foot-and-mouth disease and the impact on return to trade.* **PLOS ONE**	**2.776**	**0**
Briscoe, NJ, Elith, J, Salguero-Gómez, R, Lahoz Monfort, JJ, Camac, JS, Giljohann, KM, Holden, M, Hradsky, BA, Kearney, MR, McMahon, S, Phillips, BL, Regan, TJ, Rhodes, JR, Vesk, PA, Wintle BA, Yen, JDL & Guillera-Arroita, G (accepted) *Forecasting species range dynamics with process-explicit models: matching methods to applications.* **Ecology Letters**	**8.699**	**0**
Firestone SM, Hayama Y, Bradhurst R, Yamamoto T, Tsutsui T & Stevenson, MA (2019) *Reconstructing foot-and-mouth disease outbreaks: a methods comparison of transmission network models.* **Nature Scientific Reports**	**4.011**	**1**
Grafton, R, Doyen, L, Bene, C, Borgomeo, E, Brooks, K, Chu, L, Cumming, G, Dixon, J, Dovers, S, Garrick, D, Helfgott, A, Jiang, Q, Katic, P, Kompas, T, Little, R, Matthews, N, Ringler, C, Squires, D, Steinshamn, S, Villasante, S, Wheeler, S, Williams, J & Wyrwoll, P (2019, in press). *Realising resilience for decision-making,* **Nature Sustainability**	**n/a**	**0**
Johnson, S, Hick, P, Robinson, AP, Rimmer, A, Tweedie, A & Becker, J (2019, accepted) *The impact of pooling samples on surveillance sensitivity for the megalocytivirus Infectious spleen and kidney necrosis virus.* **Transboundary and Emerging Diseases**	**3.554**	**0**
Kompas, T, Chu, L, Van Ha, P & Spring, D (2019, in press) *Budgeting and portfolio allocation for biosecurity measures.* **The Australian Journal of Agricultural and Resource Economics**	**1.37**	**2**

CEBRA project-specific publications	InCites impact factor 2018	No. of citations as at 01/07/19
2019		
Hanea, AM & Nane, GF (2019) *Calibrating experts' probabilistic assessments for improved probabilistic predictions.* **Safety Science**	**3.169**	**0**
Hoffmann, AA, Rymer, PD, Bryne, M, Ruthrof, KX, Whinam, J, McGeoch, M, Bergstrom, DM, Guerin, GR, Sparrow, B, Joseph, L, Hill, SJ, Andrew, NR, Camac, JS, Bell, N, Riegler, M, Gardner, JL & Williams, SE (2019) *Impacts of recent climate change on terrestrial flora and fauna: some emerging Australian examples.* **Austral Ecology**	**1.403**	**1**
Hood, Y, Sadler, J, Poldy, J, Starkey, CS & Robinson, AP (2019) *Biosecurity system reforms and the development of a risk-based surveillance and pathway analysis system for ornamental fish imported into Australia.* **Preventive Veterinary Medicine**	**2.302**	**2**
Keith, JM, Spring, D & Kompas, T (2019) *'Delimiting a species's geographic range using posterior sampling and computational geometry.* **Scientific Reports**	**4.011**	**0**
Kim, JH & Robinson, AP (2019) *Interval-based hypothesis testing and its applications to economics and finance.* **Econometrics**	**1.147**	**0**
Kompas, T & Van Ha, P (2019) *The 'curse of dimensionality resolved': the effects of climate change and trade barriers in large dimensional modelling.* **Economic Modelling**	**2.188**	**2**
Lane, SE, Cannon, RM, Arthur, AD & Robinson, AP (2019) *Sample size for inspection intended to manage risk within mixed consignments.* **Neobiota**	**2.488**	**0**
Robinson, AP (2019) 'Testing simulation models using frequentist statistics.' In Beisbart, C & Saam, NJ (eds.) *Computer simulation validation: fundamental concepts, methodological frameworks and philosophical perspectives.* **Springer**	**n/a**	**1**
Trouv´e, R, Nitschke, CR, Andrieux, L, Willersdorf, T, Robinson, AP & Baker, PJ (2019) *Competition drives the decline of a midstorey tree species. Habitat implications for an endangered marsupial.* **Forest Ecology and Management**	**3.126**	**0**
2018		
Barons, MJ, Hanea, AM, Wright, SK, Baldock, KCR, Wilfert, L, Chandler, D, Dattah, S, Fannon, J, Hartfield, C, Lucas, A, Ollerton, J, Potts, SG & Carreck, NL (2018) *Assessment of the response of pollinator abundance to environmental pressures using structured expert elicitation,* **Journal of Apicultural Research**	**1.752**	**3**
Bonneau, M, Hauser, CE, Williams, NSG & Cousens, RD (2018) *Optimal schedule for monitoring a plant incursion when detection and treatment success vary over time.* **Biological Invasions**	**1.072**	**0**

Camac, JS, Condit, R, FitzJohn, RG, McCalman, L, Steinberg, D, Westoby, M, Wright, SJ & Falster, D (2018) *Partitioning mortality into growth-dependent and growth-independent hazards across 203 tropical tree species.* **Proceedings of the National Academy of Sciences**	**9.58**	**0**
Christophersen, A, Deligne, NI, Hanea, A et al (2018) *Bayesian network modelling and expert elicitation for probabilistic eruption forecasting: pilot study for Whakaari/White Island, New Zealand.* **Frontiers in Earth Science**	**2.892**	**0**
Clarke-Errey, S, Stenekes, N, Kancans, R, Woodland, C, & Robinson, AP (2018) *Undelivered risk: a counter-factual analysis of the biosecurity risk avoided by inspecting international mail articles.* **NeoBiota**	**2.488**	**0**
Decrouez, G & Robinson, AP (2018) *Bias-corrected estimation in continuous sampling plans.* **Risk Analysis**	**2.564**	**1**
Esperón-Rodríguez, M, Curran, TJ, Camac JS, Hofmann, RW, Correa-Metrio, A, Barradas, VL (2018) *Correlation of drought traits and the predictability of osmotic potential at full leaf turgor in vegetation from New Zealand.* **Austral Ecology**	**1.403**	**2**
Gill, SD, Lane, SE, Sheridan, M, Ellis, E, Smith, D & Stella, J (2018) *Why do 'fast track' patients stay more than four hours in the emergency department? An investigation of factors that predict length of stay.* **Emergency Medicine Australasia**	**1.5**	**2**
Hanea, AM, Burgman, MA & Hemming, V (2018) *IDEA for uncertainty quantification in Dias LC, Morton A & Quigley J (eds) Elicitation: the science and art of structuring judgement.* **Springer**	**n/a**	**7**
Hanea, AM & Nane, GF (2018) *The asymptotic distribution of the determinant of a random correlation matrix.* **Statistica Neerlandica**	**0.433**	**2**
Hanea, AM, Nane, GF, Cooke, RM & Wielicki, BA, (2018) *Bayesian networks for identifying incorrect probabilistic intuitions in a climate trend uncertainty quantification context.* **Journal of Risk Research**	**1.699**	**1**
Hanea, AM, McBride, M, Burgman, M & Wintle, B (2018) *The value of performance weights and discussion in aggregated expert judgements.* **Risk Analysis**	**2.564**	**5**
Hemming, V, Burgman, MA, Hanea, AM, McBride, MF & Wintle, BC (2018) *A practical guide to structured expert elicitation using the IDEA protocol***. Methods in Ecology and Evolution**	**7.099**	**23**
Hemming, V, Walshe, T, Hanea, A, Fidler, F & Burgman, M (2018) *Eliciting improved quantitative judgements using the IDEA protocol: a case study in natural resource management.* **PLOS ONE**	**2.776**	**5**
Hollings, T, Burgman, M, van Andel, M, Gilbert, M, Robinson, T, & Robinson, AP (2018) *How do you find the green sheep? A critical review of the use of remotely sensed imagery to detect and count animals.* **Methods in Ecology and Evolution**	**7.099**	**12**

Hoshino, E, Pacoe, S, Hutton, T, Kompas, T & Yamazaki, S (2018) *Estimating maximum economic yield in multispecies fisheries: a review.* **Reviews in Fish Biology and Fisheries**	**3.506**	**7**
Kompas, T, Van Ha, P & Nhu Che, T (2018) *The effects of climate change on GDP by country and the global gains from complying with the Paris Climate Accord*. **Earth's Future**	**5.781**	**6**
Kompas, T & Chu, L (2018) *MEY for a short-lived species: a neural network approach.* **Fisheries Research**	**2.343**	**2**
Lane, S, Hollings, T, Hayes, KR, McEnnulty, FR, Green, M, Georgiades, E & Robinson, AP (2018) Risk factors for fouling biomass: evidence from small vessels in Australia. **Biofouling**	**2.847**	**1**
Malishev, M, Bull CM, & Kearney, MR (2018) *An individual-based model of ectotherm movement integrating metabolic and microclimatic constraints*. **Methods in Ecology and Evolution**	**7.099**	**9**
Mariyono, J, Kuntariningsih, A & Kompas, T (2018) *Pesticide use in Indonesian vegetable farming and its determinants.* **Management of Environmental Quality: An International Journal**	**n/a**	**11**
Moore, NA, Camac JS, Morgan, JW (2018) *Effects of drought and fire on resprouting capacity of 52 temperate Australian perennial native grasses.* **New Phytologist**	**7.299**	**3**
Morgan, JW, Vincent, JD, Camac, JS (2018) *Upper range limit establishment after wildfire of an obligate-seeding montane forest tree fails to keep pace with the 20th century warming.* **Journal of Plant Ecology**	**2.282**	**3**
Spring, DA, Croft, L, Bond, NR, Cunningham, SC, Mac Nally, R & Kompas, T (2018) *Institutional impediments to conservation of freshwater dependent ecosystems*. **Science of the Total Environment**	**5.589**	**0**
van Andel, M, Hollings, T, Bradhurst, R, Robinson, AP, Burgman, M, Gates, C, Bingham, P & Carpenter, T (2018) *Does size matter to models? Exploring the effect of herd size on outputs of a herd-level disease spread simulator.* **Frontiers in Veterinary Science**	**2.029**	**1**
Werner, C, Hanea, AM & Morales-Napoles, O (2018) *Eliciting multivariate uncertainty from experts: considerations and approaches along the expert judgement process in Dias LC, Morton A & Quigley J (eds) Elicitation: the science and art of structuring judgement.* **Springer**	**n/a**	**2**



PRESENTATIONS

Building networks and communicating our research keeps CEBRA connected and accountable. Our researchers attend meetings in Australia and internationally, to share our research and stay knowledgeable about the latest developments in biosecurity and risk analysis. We regularly chair, address and facilitate workshops and conferences.

Table 7: Presentations (talks and workshops) given by CEBRA researchers in 2018–2019

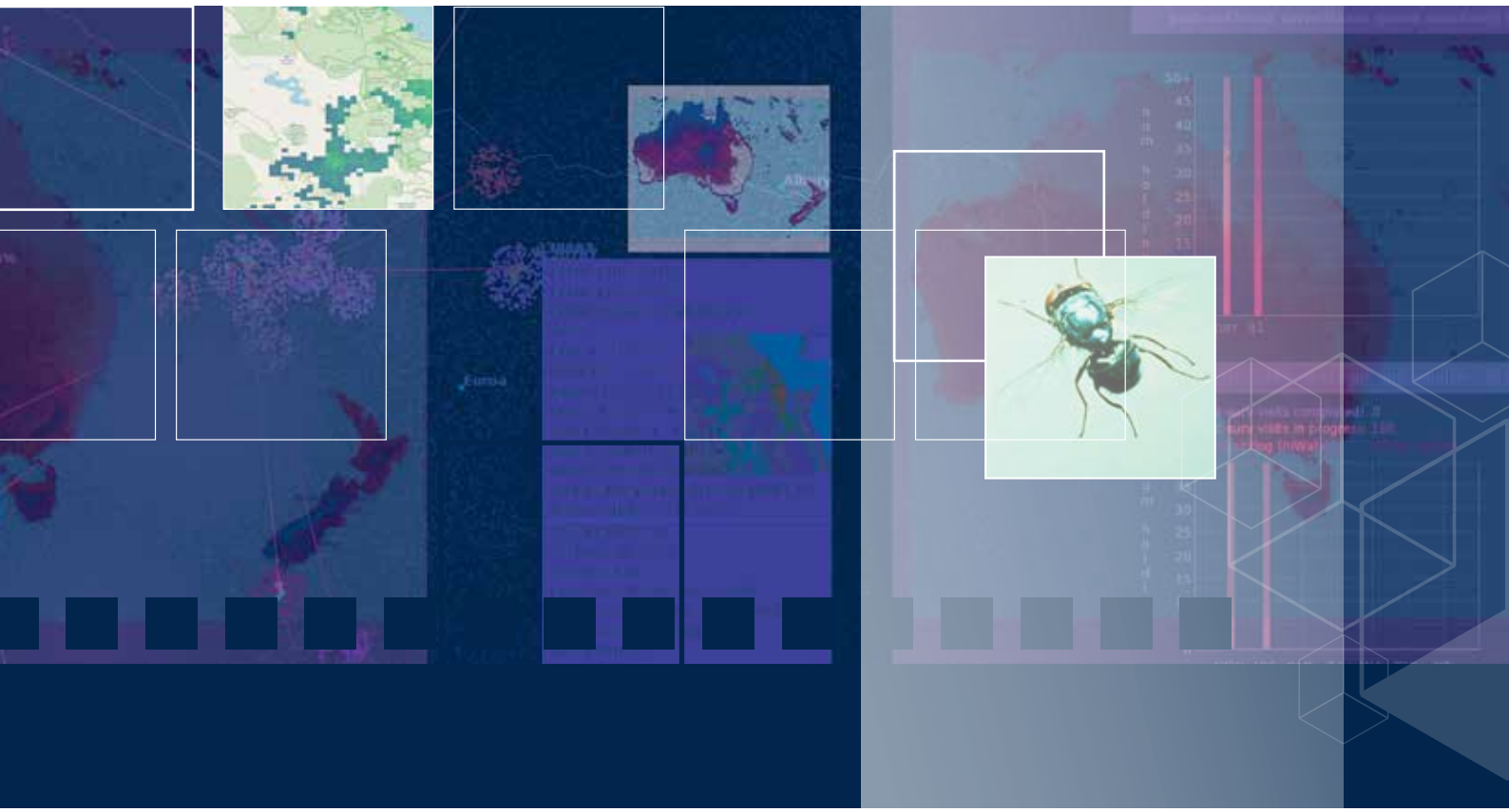
Dates of Event	Topic | Event	Location	Organisation	Facilitator
09–12 July 2018	Foot-and-mouth disease (FMD) modelling workshop	Budapest, Hungary	Food and Agriculture Organisation of the United Nations (FAO UN)	Dr Richard Bradhurst
09–13 July 2018	Risk factors for fouling biomass: evidence from small vessels in Australia | 29th International Biometrics Society Conference	Barcelona, Spain	International Biometrics Society	Dr Stephen Lane
05–08 August 2018	Come fly with me as long as it complies with the fly America policy and other US funding restrictions for non-US universities | National Council of University Research Administrators Annual Conference	Washington DC, United States of America	National Council of University Research Administrators	Ms Cassie Watts
15 August 2018	Global economic gains from complying with the Paris Climate Accord	Melbourne	School of Ecosystem and Forest Sciences, The University of Melbourne	Professor Tom Kompas
27–30 August 2018	Multi-level modeling of key performance indicators | Statistical Society of Australia Conference	Melbourne	Statistical Society of Australia	Dr Stephen Lane
28 August 2018	Biosciences visions seminar	Melbourne	The University of Melbourne	Professor Tom Kompas
10 September 2018	Quantifying uncertainty with structured expert judgement: predicting adaptive capacity in Australian alpine animal communities	Sydney	Western Sydney University	Dr Anca Hanea
12–13 September 2018	Maximum economic yield	Salerno, Italy	University of Salerno	Professor Tom Kompas
18–19 September 2018	The economic damages from climate change and the benefits of complying with the Paris Accord	London, United Kingdom	Imperial College	Professor Tom Kompas
21 September 2018	The economic damages from climate change in a global trade analysis project approach	Paris, France	IPAG Business School	Professor Tom Kompas
27 September 2018	Identifying incorrect probabilistic intuitions in climate trend uncertainty quantification context | Society for Risk Analysis – Australia and New Zealand (SRA–ANZ) Conference 2018	Sydney	SRA–ANZ	Dr Anca Hanea

Dates of Event	Topic | Event	Location	Organisation	Facilitator
27 September 2018	Biosecurity at the system scale | SRA–ANZ Conference 2018	Sydney	SRA–ANZ	Dr Aaron Dodd
27 September 2018	Biosecurity and risk analysis: multiple disciplines or multidisciplinary? | SRA–ANZ Conference 2018	Sydney	SRA–ANZ	Associate Professor Andrew Robinson
10 October 2018	The economic damages from climate change and the benefits of complying with the Paris Accord	Melbourne	Climate and Energy College, The University of Melbourne	Professor Tom Kompas
10 October 2018	Biosecurity at the system scale: where are we heading? | Queensland Biosecurity Partners Forum	Brisbane	Biosecurity Queensland	Dr Aaron Dodd
10 October 2018	Government investment in biosecurity: why, when, how and how much? | Queensland Biosecurity Partners Forum	Brisbane	Biosecurity Queensland	Dr Susie Hester
16 October 2018	Biosecurity at the system scale: what's it worth? | International Pest Risk Research Group (IPRRG) Annual Meeting	Taichung, Taiwan	IPRRG	Dr Aaron Dodd
16 October 2018	Proportional allocation of inspection resources to heterogeneous strata delivers nominal sensitivity: contradicting an international regulatory standard | IPRRG Annual Meeting	Taichung, Taiwan	IPRRG	Associate Professor Andrew Robinson
24 October 2018	The economic costs and damages from climate change in a global trade model	Canberra	Climate Change Authority	Professor Tom Kompas
29–30 October 2018	Modelling management strategies for vaccinated animals after an outbreak of FMD and the impact on return-to-trade | The European Commission for the control of foot and mouth disease (EuFMD) FAO UN International Conference	Puglia, Italy	EuFMD FAO UN	Dr Richard Bradhurst
06–07 November 2018	Introduction to R workshop	Auckland, New Zealand	MPI and Customs New Zealand Joint Border Analytics team	Dr Steve Lane
20 November 2018	Risk maps, pathways and optimal trapping for exotic and established fruit flies	Melbourne	National Fruit Fly Committee Meeting	Professor Tom Kompas
03 December 2018	A preliminary cost–benefit analysis for the eradication of yellow crazy ants	Cairns	Wet Tropics Management Authority	Professor Tom Kompas
06–07 December 2018	How to elicit models | Australasian Bayesian Network Modeling Society (ABNMS) Conference	Adelaide	ABNMS	Dr Victoria Hemming
06–07 December 2018	What is an optimal value of k in k-fold cross-validation in discrete Bayesian network analysis | ABNMS Conference	Adelaide	ABNMS	Dr Anca Hanea

Dates of Event	Topic | Event	Location	Organisation	Facilitator
04 February 2019	Predictions from machine learning in biosecurity	Brisbane	National Biosecurity Committee Working Group	Associate Professor Andrew Robinson
04 February 2019	Visions of a digital, data-driven biosecurity system | National Biosecurity Committee Research and Innovation Working Group	Brisbane	Biosecurity Queensland	Dr Aaron Doddd
07 February 2019	Global economic gains from complying with the Paris Climate Accord | ANU Climate Update 2019	Canberra	The Australian National University (ANU)	Professor Tom Kompas
08 February 2019	Introduction to risk management	Orange	NSW Department of Primary Industries	Professor Tom Kompas and Dr Terry Walshe
11–16 February 2019	Biosecurity risk and response | International masterclass in plant biosecurity, Universitas Kristen Satya Wacana	Salatiga, Indonesia	The Crawford Fund, Indonesian Biosecurity Foundation, Plant Biosecurity Science Foundation and the Centre for Agriculture and Bioscience International	Dr Susie Hester
12–15 February 2019	Portfolio allocation across investments for biosecurity | Australasian Agricultural and Resource Economics Society (AARES) Conference 2019	Melbourne	AARES	Professor Tom Kompas
13 February 2019	How agent-based models can help with biosecurity | AARES Conference 2019	Melbourne	AARES	Dr Richard Bradhurst
13 February 2019	Biosecurity at the system scale: what's it worth? | AARES Conference 2019	Melbourne	AARES	Dr Aaron Dodd
20 February 2019	Structured elicitation of expert judgement | Conference on Uncertainty in Risk Analysis	Berlin, Germany	European Food Safety Authority and the German Federal Institute for Risk Assessment	Dr Anca Hanea, Dr Victoria Hemming
21 February 2019	Structured expert judgement	Berlin, Germany	European Food Safety Authority and the German Federal Institute for Risk Assessment	Dr Anca Hanea
04–05 March 2019	Expert meeting on incorporating wildlife compartments in FMD simulation modelling	Parma, Italy	European Food Safety Authority	Dr Richard Bradhurst
07 March 2019	Steering committee meeting for the European FMD model	Rome, Italy	European Commission for the control of foot and mouth disease (within the FAO of the UN)	Dr Richard Bradhurst

Dates of Event	Topic | Event	Location	Organisation	Facilitator
22 March 2019	Modelling the spread of yellow crazy ant	Cairns	Wet Tropics Management Authority	Dr Richard Bradhurst
22 March 2019	Bonamia risk model workshop	Wellington, New Zealand	Cawthron Institute	Dr Anca Hanea
07 April 2019	Arid elicitation workshop	Canberra	ANU	Dr Anca Hanea
26 April 2019	Mathematics and some uses | Year 6 cohort presentation	Mt Eliza	Kunyung Primary School	Associate Professor Andrew Robinson
06–08 May 2019	Does size matter (to biosecurity risk at the border)? | SRA 5th World Congress on Risk	Cape Town, South Africa	Society for Risk Analysis	Associate Professor Andrew Robinson
07–08 May 2019	Bad biosecurity behavior, rational response to rules, or the wrong incentives? | Fifth National Science Exchange Conference 2019	Canberra	Department of Agriculture	Dr Susie Hester
07–8 May 2019	Fifth national science exchange conference 2019	Canberra	Department of Agriculture	Dr Edith Arndt
15–17 May	Risk assessment for biosecurity: where to next and why? | National Symposium on Biological Invasions	Tulbagh, South Africa	Centre for Invasion Biology (CIB), University of Stellenbosch	Associate Professor Andrew Robinson
02 June 2019	Modelling the spread and control of national priority plant pests	Canberra	Department of Agriculture	Dr Richard Bradhurst
05 June 2019	Biosecurity risk insurance workshop	Canberra	Department of Agriculture	Dr Richard Bradhurst
12–13 June 2019	Smarter border biosecurity: a strategic risk-based approach to allocating effort	Gold Coast	Australian Biosecurity Symposium	Associate Professor Andrew Robinson
12–13 June 2019	Undelivered risk: a counter-factual analysis of the biosecurity risk avoided by inspecting international mail	Gold Coast	Australian Biosecurity Symposium	Associate Professor Andrew Robinson
12–13 June 2019	Bad biosecurity behavior or rational reaction to rules? Aligning stakeholder incentives through insurance	Gold Coast	Australian Biosecurity Symposium	Dr Susie Hester
12–13 June 2019	Estimating the monetary value of Australia's biosecurity system	Gold Coast	Australian Biosecurity Symposium	Dr Aaron Dodd
29–30 June 2019	Bonamia risk model expert elicitation	Nelson, New Zealand	Cawthron Institute	Dr Anca Hanea, Dr James Camac

GOVERNANCE



CHAIR'S REPORT – CEBRA ADVISORY BOARD

CEBRA focuses on the future of biosecurity.

It was a busy year for CEBRA staff who worked on more than 20 projects, delivered 51 presentations at national and international forums, and had 40 papers accepted for publication in national and international journals. By any measure, this is an impressive performance by an organisation that has its sights firmly set on improving biosecurity outcomes for Australia and New Zealand.

The CEBRA Advisory Board (CAB) was busy oversighting this activity, while undergoing some change of membership. We were delighted to welcome Ms Sarah Corcoran as an independent member of the board. Sarah is the executive director of Biosecurity and Animal Welfare, Department of Primary Industry and Resources in the Northern Territory. Prior to this, Sarah was the director of the Biosecurity Control Centre in the Queensland Department of Agriculture and Fisheries. As such, she brings a wealth of experience in tropical biosecurity to the CAB.

Sarah replaced Dr Roger Paskin who retired earlier in the year, after many years on the boards of both CEBRA and its predecessor, ACERA. We thank Roger for his steadfast support and his many insightful contributions to board discussions, and wish him a long and happy retirement.

This is an important evolution for the board, which has not previously had a member with specialist knowledge of the biosecurity risks related to tropical pests and diseases. We are grateful to Sarah for accepting the invitation to become a CAB member. The CAB now has members from Australia's key biosecurity regions, as well as New Zealand, with expertise in a number of disciplinary specialities.

CEBRA continues to undertake a rigorous annual work program of projects identified as important by the Australian and New Zealand governments through the Biosecurity Research and Innovation Steering Committee. Among these are two large strategic projects that consider how to measure the value created by Australia's biosecurity system (CEBRA 170713) and how to evaluate the performance or health of the system at the national level (CEBRA 170714).

The 'value project' has developed a rigorous method to assess the market and non-market benefits that the system delivers to the Australian community, while the 'health project' has developed a framework for evaluating how well the system delivers this value. Both projects are significant because they have taken CEBRA into new territory, dealing with the entire Australian biosecurity system rather than its component parts.

Another key project has been a review of the considerable body of work that has been undertaken by CEBRA and ACERA over the past thirteen years. The intent of this project is to classify all CEBRA and ACERA projects into broad categories encompassing the biosecurity activity the project informs, the analytical method used by the project, the biosecurity risk pathway targeted by the project, and the biology of interest. The analysis also includes the budget allocated to each of the projects in order to weight the classifications.

It is intended that the outcome of this project will inform, in an easily interpreted way, where the governments have focused their work to date and highlight areas that might benefit from future effort. Work is now progressing to publish a report on this project for broader consumption.

This work also provides the foundation for CEBRA to assess the real impact it has made on biosecurity risk management in Australia and New Zealand. CEBRA is focused on impact and through its many projects has provided evidence-based science that underpins pragmatic solutions to contemporary biosecurity problems.

Measuring the impact of research is not easy, especially in the short term, but CEBRA is now well placed to consider how its body of work has had practical impacts on the way biosecurity risk is managed in Australia and New Zealand. Developing and implementing rigorous approaches to measuring this impact will be an important focus in coming years.

Biosecurity risk management will inevitably become more complex over time with growth in trade, tourism and migration, and with climate change increasing the risks of pest and disease spread. There are important, evidence-based judgements that need to be made in order to protect the agricultural industries, environment and community health of Australia and New Zealand into the future.

National biosecurity systems must make judgements about where best to invest their limited resources in this constantly evolving environment. CEBRA will continue to assist in this endeavour to keep both countries at the forefront of biosecurity management.

Dr Colin J Grant
BSc (Hons), PhD JCU OA

CEBRA ADVISORY BOARD MEMBERS

Name	Position	Organisation
Dr Colin Grant	Chair	Independent
Dr Steve Hatfield-Dodds	Board member	Executive Director, Australian Bureau of Agricultural and Resource Economics and Sciences
Dr Marion Healy	Board member	First Assistant Secretary, Biosecurity Plant Division, Department of Agriculture
Ms Christine Reed	Board member	Biosecurity Science and Risk, Ministry for Primary Industries New Zealand
Associate Professor Roger Paskin	Board member	Chief Veterinary Officer, Biosecurity South Australia, Primary Industries and Regions South Australia
Ms Sarah Corcoran	Board member	Executive director, Biosecurity and Animal Welfare, Department of Primary Industries and Resources, Darwin
Professor Helen Sullivan	Board member	Director, Crawford School of Public Policy, The Australian National University
Professor Ian Robertson	Board member (Scientific Advisory Committee Chair)	Professor of veterinary epidemiology, College of Veterinary Medicine, Murdoch University
Professor Pauline Ladiges	Board member (host)	Professorial fellow, Botany, School of BioSciences, The University of Melbourne
Professor Peter Taylor	Board member (host)	Director, Australian Research Council Centre of Excellence for Mathematical and Statistical Frontiers, School of Mathematics and Statistics, The University of Melbourne
Associate Professor Andrew Robinson	Board member (ex offico)	Director, Centre of Excellence for Biosecurity Risk Analysis, The University of Melbourne
Professor Tom Kompas	Board member (ex offico)	Centre of Excellence for Biosecurity Risk Analysis, The University of Melbourne

SCIENTIFIC ADVISORY COMMITTEE TERMS OF REFERENCE

The Scientific Advisory Committee (SAC) reviews and approves all draft project plans and provides an assessment of all final reports.

The role of the SAC is to:

- assist the director in evaluating research proposals based on criteria of:
  - scientific and practical merit for risk analysis
  - capacity/capability to deliver
  - budget viability
- obtain peer reviews of final reports prior to submission to the Department of Agriculture for endorsement
- provide relevant advice to researchers conducting CEBRA projects, as requested by the director.

The composition of the SAC will be:

- Chair Professor Emeritus Ian Robertson
- a broad committee of members covering relevant fields of environmental, animal and plant sciences; biosecurity; physical, mathematical and social sciences; psychology; philosophy; and statistics.

The responsibilities of SAC members will be as follows:

- The chair will seek advice and peer reviews from appropriate SAC members and other colleagues on proposals, and interim and final reports, as appropriate. Reviews will be forwarded to investigators for their consideration.
- SAC members may be provided with copies of project proposals or interim reports, and may be invited, without obligation, to provide advice to researchers or the SAC.
- The chair will attend advisory board meetings to report on SAC matters.

It is anticipated that most of the business of the SAC will be conducted electronically. Formal meetings may be called at the discretion of the chair in consultation with the director.

SAC REVIEWERS FOR 2018–2019

Name	Organisation
Dr Paul DeBarro	Health and Biosecurity, Commonwealth Scientific and Industrial Research Organisation
Professor Oscar Cacho	University of New England
Dr Arthur Campbell	Monash University
Dr Barney Caton	Center for Plant Health Science and Technology, United States Department of
Dr Brendan Cowled	Ausvet
Professor Uwe Dulleck	Queensland University of Technology
Dr Karyn Froud	Biosecurity Research Ltd, New Zealand
Dr Gideon Gal	Israel Oceanographic and Limnological Research
Dr Pablo Garcia-Diaz	Manaaki Whenua Landcare Research, New Zealand
Professor Chad Hewitt	Murdoch University
Professor Phil Hulme	Lincoln University
Dr Lisa Jamieson	Rangahau Ahumāra Plant and Food Research, New Zealand
Dr Tanya Latty	University of Sydney
Dr Ryan McAllister	Cooperative Research Centre for Plant Biosecurity, Commonwealth Scientific and
Professor Simon McKirdy	Murdoch University
Dr Hugh Millar	Hugh Millar and Associates Pty Ltd
Dr Michael Ormsby	Ministry for Primary Industries, New Zealand
Associate Professor Roger Paskin	Independent consultant
Professor John Rolfe	Central Queensland University
Professor Shashi Sharma	Independent consultant
Dr Rieks van Klinken	Cooperative Research Centre for Plant Biosecurity, Commonwealth Scientific and
Associate Professor Ben White	The University of Western Australia
Dr Stuart Whitten	Land and Water, Commonwealth Scientific and Industrial Research Organisation
Dr Peter Whittle	AgKonect Pty Ltd

KEY PERFORMANCE INDICATORS

CEBRA's objectives and outcomes against key performance indicators are summarised in the following table. In the majority of cases, the KPIs were on target or completed.

Activity – Research						
Strategic Objective			**Accountability**	**Rating Key**		**Progress/Outcome**
To research and develop methods relevant to biosecurity risk by engaging a range of disciplines relevant to the analysis of biosecurity risk, so that the Australian and New Zealand governments remain at the forefront of practical biosecurity risk assessment.			Director	○ Over performance ¤ On target ☒ Target at risk ♢ Target not achieved ✪ Completed		¤ On target
Key Performance Indicator		**Measure**	**Officer**	**Delivery Date**	**Rating**	**Progress/Outcome**
1.1	Research project quality and completion rates achieve a high standard	At least 90% of project proposals are approved, pending budget allocations	Director, Biosecurity Research Team, SAC	Ongoing	¤	2019–20 project proposals have been approved and MPI projects are currently under development
		At least 90% of outputs (milestones, reports, systems, software, guidelines etc.) completed satisfactorily	Director, business manager	Ongoing	¤	The satisfactory completion of outputs continues to track above 90%
		At least 80% outputs completed on time per year	Director	Ongoing	¤	The on-time completion of project deliverables is currently tracking toward the 80% target
		At least 90% of projects to be delivered on budget	Director, business manager	Ongoing	¤	Projects continue to track on or below budget
1.2	Research projects contribute positively to the University's Excellence in Research for Australia (ERA) ranking based on standard measures	Organisational H-Index ranking	Director	Ongoing	¤	CEBRA's H-index is 24 CEBRA/ACERA's combined H-index is 62
		Number of Publications per year by CEBRA staff	Director	Ongoing	¤	CEBRA staff members have published numerous journal articles badged as CEBRA work (details are provided in Table 6)
1.3	Biosecurity risk analysis capacity in Australia and New Zealand is enhanced	Number of research higher degree students enrolled	Director	Ongoing	¤	CEBRA is currently supporting three higher degree students
		Number of research higher degree students graduated	Director	Ongoing	¤	No PhD students have graduated in the last twelve months
		Number of post-doctoral research fellows employed	Director	Ongoing	¤	Seven postdoctoral research fellows are funded through the CEBRA grant and work directly on CEBRA projects: • Edith Arndt • Jason Whyte • Richard Bradhurst • James Camac • Steve Lane finished 31/05/19 • Anca Hanea • Rezvan Hatami finished 28/06/19 Two additional postdoctoral research fellows are funded from alternate sources but contribute to the CEBRA research portfolio: • Aaron Dodd • Danny Spring

Activity – Research						
Strategic Objective			**Accountability**	**Rating Key**		**Progress/Outcome**
To research and develop methods relevant to biosecurity risk by engaging a range of disciplines relevant to the analysis of biosecurity risk, to that the Australian and New Zealand governments remain at the forefront of practical biosecurity risk assessment.			Director	○ Over performance ¤ On target ☒ Target at risk ◊ Target not achieved ✪ Completed		¤ On target
Key Performance Indicator		**Measure**	**Officer**	**Delivery Date**	**Rating**	**Progress/Outcome**
1.4	Engagement and collaboration between CEBRA funding bodies and other organisations in planning and conducting CEBRA research projects	Director engages with DAWR (BRISC) to discuss context and details of research projects	Director	held on: • 28 Aug 2018 • 28 Nov 2018 • 14 Mar 2019 • 19 Jun 2019	✪	The centre's executive management have been represented at each BRISC meeting to report on Centre activities and to foster engagement with funding bodies
		Director engages with the Ministry for Primary Industries to discuss context and details of research projects	Director	Ongoing	¤	The director visits the Ministry for Primary Industries at least four times per year to discuss projects and practices
		At least three substantial collaborations with other research organisations per year	Director	Ongoing	¤	No new collaboration agreements have been executed in 2018–2019, however collaborations continued with: • Scion Research, New Zealand • Lincoln University, New Zealand
1.5	Peer review of all draft project plans	Scientific Advisory Committee successfully reviews and oversees revision of all project reports	Director, SAC chair	Ongoing	¤	The SAC will review all submitted business cases and provide constructive feedback to proponents to improve proposals

Activity - Communications						
Strategic Objective			**Accountability**	**Rating Key**		**Progress/Outcome**
To document and communicate research findings to governments and others engaged in biosecurity decision making in order to promote excellence in risk analysis			Director, Business Manager, Communications PR	○ Over performance ◎ On target ☒ Target at risk ◊ Target not achieved ✪ Completed		◉ On target
Key Performance Indicator		**Measure**	**Officer**	**Delivery Date**	**Rating**	**Progress/Outcome**
2.1	An effective flow of media information and publicity about the objectives and achievements of CEBRA	At least 2 informative media stories per year	Director, business manager, communications PR	Ongoing	◉	CEBRA e-newsletter distributed quarterly and news items regularly placed on website and social media
		Use of website, blogs and social media to increase brand awareness. An average of 1,000 website page views per month				CEBRA Facebook page and Twitter account are regularly updated
		At least three working groups conducted and three summaries completed per year				CEBRA staff have completed at least three workshops in the reporting period (detailed information is provided in Table 7)
2.2	Regular involvement in national and international conferences and similar forums	At least twelve national presentations by CEBRA participants (badged as CEBRA work) per year	Director	Ongoing	○	CEBRA staff have made at least twelve presentations badged as CEBRA work (detailed information is provided in Table 7)
		At least two international presentations by CEBRA participants (badged as CEBRA work) per year				CEBRA staff have made at least six international presentations badged as CEBRA work (detailed information is provided in Table 7)
2.3	Broad recognition of CEBRA as a centre of standing in quality research	At least three invitations to chair or host conferences, or to participate in key advisory forums	Director	Ongoing	◉	CEBRA staff have made at least three plenary presentations (detailed information is provided in Table 7)
		At least one international visitor per year				CEBRA has hosted: Mark Ducey, University of New Hampshire, USA • Sandy Liebhold, United States Department of Agriculture • Olalekan Obisesan, University of Ibadan, Nigeria • Mark Burgman, Imperial College, London, UK • Melissa Welsh, Scion, NZ
		At least one visit to international laboratories by CEBRA personnel per year				Associate Professor Andrew Robinson visited the Centre for Invasion Biology at the University of Stellenbosch in South Africa

Activity – Adoption						
Strategic Objective			**Accountability**	**Rating Key**		**Progress/Outcome**
To improve the adoption of CEBRA outputs by the Australian and New Zealand biosecurity authorities in support of strengthening the integrity of biosecurity systems based on risk management			Director, government CEBRA Advisory Board (CAB) members	○ Over performance ¤ On target ☒ Target at risk ◊ Target not achieved ✪ Completed		¤ On target
Key Performance Indicator		**Measure**	**Officer**	**Delivery Date**	**Rating**	**Progress/Outcome**
3.1	Use of CEBRA materials is routine in government biosecurity management	Each CEBRA project proposal has at its inception a clearly articulated and measureable adoption/uptake strategy (one page)	Biosecurity research section (Department of Agriculture) and Ministry for Primary Industries	Prior to project approval	¤	Each business case in the work plan has a clearly articulated adoption/ uptake section
		Director to report on completion of CEBRA research outputs to the Department of Agriculture and Ministry for Primary Industries	Director	Ongoing	¤	Director provides summary of completed research findings to the Department of Agriculture and Ministry for Primary Industries
		Department of Agriculture and Ministry for Primary Industries CAB members to provide advice on adoption of project outputs to CAB twice per year, including details of transfer of capability	Biosecurity research section (Department of Agriculture) and Ministry for Primary Industries	Twice per year	¤	Biosecurity research section confirms progress towards adoption reporting is on track
3.2	Achievement of a high rate of research project endorsement by the Department of Agriculture	At least 90% of submitted project outputs are endorsed by the Department of Agriculture per year	Director, BRISC	Ongoing	✪	The following reports were submitted for endorsement: • 1606C final report • 1606D final report • 1606E final report • 1608A final report • 1608B final report • 170714 final report (phase 2) Endorsements received: • 1404C (03/07/18) • 1606C (26/10/18) • 1606D (18/03/19) • 1606E (14/08/18) • 1608A (07/01/19) • 1608B (18/01/19) • 1608E (03/07/18)

Activity – Governance						
Strategic Objective			**Accountability**	**Rating Key**		**Progress/Outcome**
To manage CEBRA in accordance with the funding agreement, strategic objectives and key performance indicators, taking account of relevant industry standards and best practice guidelines			Director, chair	○ Over performance ¤ On target ☒ Target at risk ◊ Target not achieved ✪ Completed		¤ On target
Key Performance Indicator		**Measures**	**Officer**	**Delivery Date**	**Rating**	**Progress/Outcome**
4.1	Budget and workplan developed and approved annually	Submit to Department of Agriculture and Ministry for Primary Industries a budget and work plan for research projects each financial year	Business manager	14 Jul	✪	The budget and work plan was submitted to Department of Agriculture and Ministry for Primary Industries on 13/07/18
		Review budget and work plan and approve (subject to amendments)	Department of Agriculture /Ministry for Primary Industries	31 Jul	✪	Department of Agriculture and Ministry for Primary Industries approved the budget and work plan on 19/07/18
4.2	Payment of funding in support of CEBRA	Department of Agriculture and Ministry for Primary Industries to pay CEBRA funding payments twice annually	Department of Agriculture /Ministry for Primary Industries	31 Jan 31 Jul	✪	IInvoices issued to: Department of Agriculture • Invoice No. 762269 issued on 02/07/18 • Invoice No. 771755 issued on 03/01/19 Ministry for Primary Industries • Invoice No. 781401 issued on 03/07/19 • Invoice No. 771791 issued on 03/01/19
		The University of Melbourne contributes $450 312 in funds and $1 000 364 in-kind per annum, the latter being support for CEBRA Staff, including space for the CEBRA IT system maintenance and general administrative support	Business manager	Mar 2018	✪	• $300,208 received from The University's Chancellery Strategic Investment (DVCR) on 31/01/19 • $75 052 received from the Faculty of Science on 08/02/19 • $75 052 received from the School of BioSciences on 31/03/18 • In-kind contribution has been calculated at $1 057149 for 2018–2019

4.3	Provide regular reports to funding partners on CEBRA activities as required in the funding agreement	CEBRA to provide Department of Agriculture and Ministry for Primary Industries with progress reports as set out in schedule 3 of the funding agreement	Business manager	• 31 Mar • 31 Jul • 30 Nov	✪	PR #15 was submitted to the Department of Agriculture and the Ministry for Primary Industries on 30/07/18 PR #16 was submitted to Department of Agriculture and the Ministry for Primary Industries on 29/11/18 PR #17 was submitted to the Department of Agriculture and the Ministry for Primary Industries on 29/03/19
		CEBRA to provide Department of Agriculture and Ministry for Primary Industries with a financial report for the preceding six months biannually as set out in schedule 3 of the funding agreement	Business manager	• 21 Jan • 16 Jul	✪	FR #10 was submitted to Department of Agriculture and the Ministry for Primary Industries on 13/07/18 FR #11 was submitted to Department of Agriculture/ Ministry for Primary Industries on 17/01/19
4.4	Provide an annual report on CEBRA activities and performance annually, and an auditor's report confirming that CEBRA has managed funding and maintained appropriate accounts and records	CEBRA to supply Department of Agriculture and Ministry for Primary Industries with an annual report and auditor's report as set out in schedule 4 of the funding agreement	Business manager	Annual report: 30 Sep Auditor's report: 31 Aug	✪	The annual report was submitted to the Department of Agriculture and the Ministry for Primary Industries on 30/09/18 and the auditor's report was submitted to the Department of Agriculture and Ministry for Primary Industries on 13/08/18
4.5	Provide a final report on Centre activities at the completion of the term of the funding agreement	CEBRA to supply Department of Agriculture and Ministry for Primary Industries with a final report for the term of the agreement as set out in schedule 4 of the funding agreement	Business manager	30 Sep 2021	⊙	Not required in the reporting period
4.6	The CEBRA Advisory Board advises on broad direction setting for risk analysis research	The CAB meets four times per year with a minimum attendance of 80% of members (maximum of two members missing)	Board chair, director	10 Aug 2018 9 Nov 2018 22 Feb 2019 31 May 2019	✪	To date, all meetings were held as indicated
		Conduct one CAB meeting every second year in New Zealand commencing 2018	Board chair, director, NZ member	9 May	✪	Board meeting #20 was held in Wellington NZ on 09/05/18
		The board comprises a range of experience appropriate to the objectives of CEBRA as set out in schedule 2 of the funding agreement	Board chair, director	Annual review of membership	✪	The board is comprised of an independent chair and members drawn from the Department of Agriculture, the Ministry for Primary Industries, the University of Melbourne, a state jurisdiction and tertiary Institutions
4.7	Conduct a twice yearly review of CAB performance with a view to achieving best practice in quality of advice and organisational management	Biannual review questionnaire completed by all board members and discussed at appropriate board meeting	Board chair	May–Aug 2019	✪	Review completed and presented at CAB Meeting #24 on 31/05/19

FINANCIAL STATEMENTS

FINANCIAL REPORT SUMMARY

CEBRA FINANCIAL STATEMENT 2017-2018	
INCOME	
Balance Brought Forward	$98 395
Department of Agriculture	$1 781 000
Ministry for Primary Industries	$367 665
Host contribution	$450 312
Interest	$21 485
SUBTOTAL	**$2 620 462**
OPERATING FUNDS (REVENUE + BALANCE CARRIED FORWARD)	**$2 718 857**
LESS EXPENDITURE	
Salaries	$246 791
Operations	$10 006
Business development	$184 356
Research contracts	$1 954 020
SUB-TOTAL	**$2 395 173**
BALANCE	**$323 684**

CEBRA IN-KIND STATEMENT

	%	$
Infrastructure costs: staff (on campus laboratory) $86 490/FTER per annum (grant funded)		
Payroll costs for Research Staff (Melb Uni funded)		
Dr D Spring	10%	$15 952
Dr A Dodd	50%	$73 856
	SUB-TOTAL	**$89 808**
Infrastructure costs: staff (on campus laboratory) $86 490/FTER per annum (grant and University of Melbourne funded)		
Associate Professor A Robinson	100%	$86 490
Professor T Kompas	50%	$43 245
Dr S Lane	92%	$79 283
Dr E Arndt	60%	$51 894
Dr J Camac	99%	$85 193
Dr R Bradhurst	96%	$83 030
Ms K Schneider	60%	$51 894
Dr A Hanea	51%	$43 678
Dr J Whyte	75%	$64 867
Dr C Hauser	20%	$17 298
Dr R Hatami	100%	$86 490
Ms C Watts	62%	$53 191
Ms E Kecorius	60%	$51 894
Dr D Spring	10%	$8 649
Dr A Dodd	50%	$43 245
	SUB-TOTAL	**$850 341**
Infrastructure costs: RHD student (on campus laboratory) $39 000/FTER per annum		
N Attanayake	100%	$39 000
T Vino	100%	$39 000
G Dharmarathne	100%	$39 000
	SUB-TOTAL	**$117 000**
		$1 057 149

AUDITORS REPORT

DENCH McCLEAN CARLSON

CORPORATE ADVISORY

13 August 2019

INDEPENDENT AUDIT REPORT

TO COMMONWEALTH OF AUSTRALIA – DEPARTMENT OF AGRICULTURE IN RELATION TO THE FUNDING AGREEMENT FOR THE CENTRE OF EXCELLENCE FOR BIOSECURITY RISK ANALYSIS (CEBRA)

I advise that an audit has been conducted of the Financial Statement and In-kind Support Statement for the Centre of Excellence for Biosecurity Risk Analysis the period 1 July 2018 to 30 June 2019.

AUDIT OBJECTIVE

The objective of the audit was to provide an auditor's report in accordance with clause 20.4 of the Funding Agreement. Specifically, this includes forming an opinion on whether the financial reports provided under this clause are true and fair and the University of Melbourne has complied with its obligations to expend grant payments in accordance with the Agreement.

AUDIT SCOPE

The audit was conducted in accordance with Australian Auditing Standards to provide reasonable assurance as to whether the financial statements are free of material misstatement. The audit procedures included an examination, on a test basis, of evidence supporting the amounts in the financial statements. The funds form part of the University's overall accounts, which have been audited and signed off by the Victorian Auditor-General's Office.

The prevention and detection of fraudulent activity is the responsibility of University of Melbourne management. Our audit procedures were conducted with a focus on addressing specific objectives from a control system design perspective. We did not examine all transactions over the defined review period, and while an outcome of these procedures may be the detection of fraud, this was not the objective of the review. As a consequence, we do not provide a guarantee that all errors or omissions, whether intentional or otherwise were detected.

AUDIT OPINION

I confirm that in my opinion:

- the University has incurred $2,395,173.46 expenditure on the Project; and
- the contributions of the University are $450,312.00 in cash and $1,057,148.64 in-kind in accordance with the terms of the Agreement.

The Financial Statement and Summary of In-kind Support Statement signed by the Director of the Australian Centre of Excellence for Biosecurity Risk Analysis, and a report from the Director certifying that the Centre has undertaken the Core Activities in accordance with the Agreement are attached.

Craig Geddes
Partner
Dench McClean Carlson Pty Ltd

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Website: www.dmcca.com.au

OUTLOOK

FUTURE OUTLOOK

Biosecurity in Australia, New Zealand and around the world is a shifting and multi-faceted challenge. Changing global lifestyles, trade and environment affect the likelihood of pests arriving, establishing and impacting Australia and New Zealand's agriculture, environment, economy and people.

In the face of this shifting challenge, CEBRA supports the essential work of the Australian Department of Agriculture and the New Zealand Ministry for Primary Industries through research that is both practical and innovative. Our goal is to build tools and deliver advice to assist decision makers that are faced with difficult problems.

A healthy biosecurity system is integral to maintaining the value of Australia and New Zealand's agriculture, protecting environmental assets, and defending human health.

Our research priorities for 2019–20 are to continue *strengthening surveillance,* and to develop or introduce new ways that our stakeholders can analyse and benefit from their considerable stockpiles of *data and information*.

Department of Agriculture

Strengthening surveillance

Project ID 190606: Estimating worldwide brown marmorated stink bug risk of establishment

Data and information

Project ID 190801: Automated image analysis for identifying biofouling risk on vessels

Project ID 190803: Updating the vessel check biofouling risk assessment framework

Project ID 190804: Re-evaluating management of established pests including the European wasp, *Vespula germanica* using biocontrol agents

Project ID 190808: Ensuring a whole-of-department approach to the prioritisation of biosecurity risk and the setting of regulatory intervention levels

Project ID 190810: Advanced profiling for travellers and mail

Ministry for Primary Industries

Project ID 19NZ02: Strength of evidence: definition and measurement

Project ID 19NZ03: Risk–return: economic measurement of impacts

July 2019 – June 2020

Strengthening surveillance

$191 000

Project ID: 190606 ♦ JC
Project Title: Estimating worldwide brown marmorated stink bug risk of establishment
Division: Biosecurity Plant
2019–20: $191 000

Data and information

$761 200

Project ID: 190801 ♦ NB
Project Title: Automated image analysis for identifying biofouling risk on vessels
Division: Biosecurity Animal
2019–20: $160 700

Project ID: 190803 ♦ EA
Project Title: Updating the vessel check biofouling risk assessment framework
Division: Biosecurity Animal
2019–20: $206 000

Project ID: 190804 SH
Project Title: Re-evaluating management of established pests including the European wasp, *Vespula germanica* using biocontrol agents
Division: Biosecurity Plant
2019–20: $137 200

Project ID: 190808 AR
Project Title: Ensuring a whole-of-department approach to the prioritisation of biosecurity risk and the setting of regulatory intervention levels
Division: Biosecurity Operations
2019–20: $124 000

Project ID: 190810 AR
Project Title: Advanced profiling for travellers and mail
Division: Biosecurity Compliance
2019–20: $133 300

NZ MPI

$119 300

Project ID: 19NZ02 ❖TK
Project Title: Strength of evidence: definition and measurement
Division: MPI
2019–20: $69 300

Project ID: 19NZ03 ❖TK
Project Title: Risk–return: economic measurement of impacts
Division: MPI
2019–20: $50 000

Key
AR – Andrew Robinson
SH – Susie Hester
TK – Tom Kompas
JC – James Camac
EA – Edith Arndt
NB – Nathaniel Bloomfield
TBC – To be confirmed
❖ – NZ MPI project
♦ – Collaborative with NZ MPI

FUNDING
2019–20: $1 071 500

Last updated 26/09/19

GLOSSARY

AADIS: Australian animal disease model

AARES: Australasian Agricultural and Resource Economics Society

ABARES: Australian Bureau of Agricultural Resource Economics and Sciences

ABNMS: Australasian Bayesian Network Modelling Society

ACBEE: Australian Centre for Biosecurity and Environmental Economics

ACERA: Australian Centre of Excellence for Risk Analysis (precursor of CEBRA)

ANAO: The Australian National Audit Office

ANU: The Australian National University

BMSB: brown marmorated stink bug

CA: competent authority

CAB: CEBRA Advisory Board

CBIS: Compliance-Based Intervention Scheme (formerly, compliance-based inspection scheme)

CCEPP: Consultative Committee on Emergency Plant Pests

CEBRA: Centre of Excellence for Biosecurity Risk Analysis

CSP: continuous sampling plan

DOC: New Zealand Department of Conservation

ERA: Excellence in Research for Australia

EuFMD: The European Commission for the control of foot and mouth disease

FAO UN: Food and Agriculture Organization of the United Nations

FMD: foot-and-mouth disease

IGAB: Intergovernmental Agreement on Biosecurity

IPRRG: International Pest Risk Research Group

Markov SAA: Markov chain Monte Carlo stochastic approximation

MPI: Ministry for Primary Industries

NAQS: Northern Australia Quarantine Strategy

NEBRA: National Environmental Biosecurity Response Agreement

NIAS: National Invasive Ant Surveillance Programme

NMG: National Management Group

NMV: non-market valuation

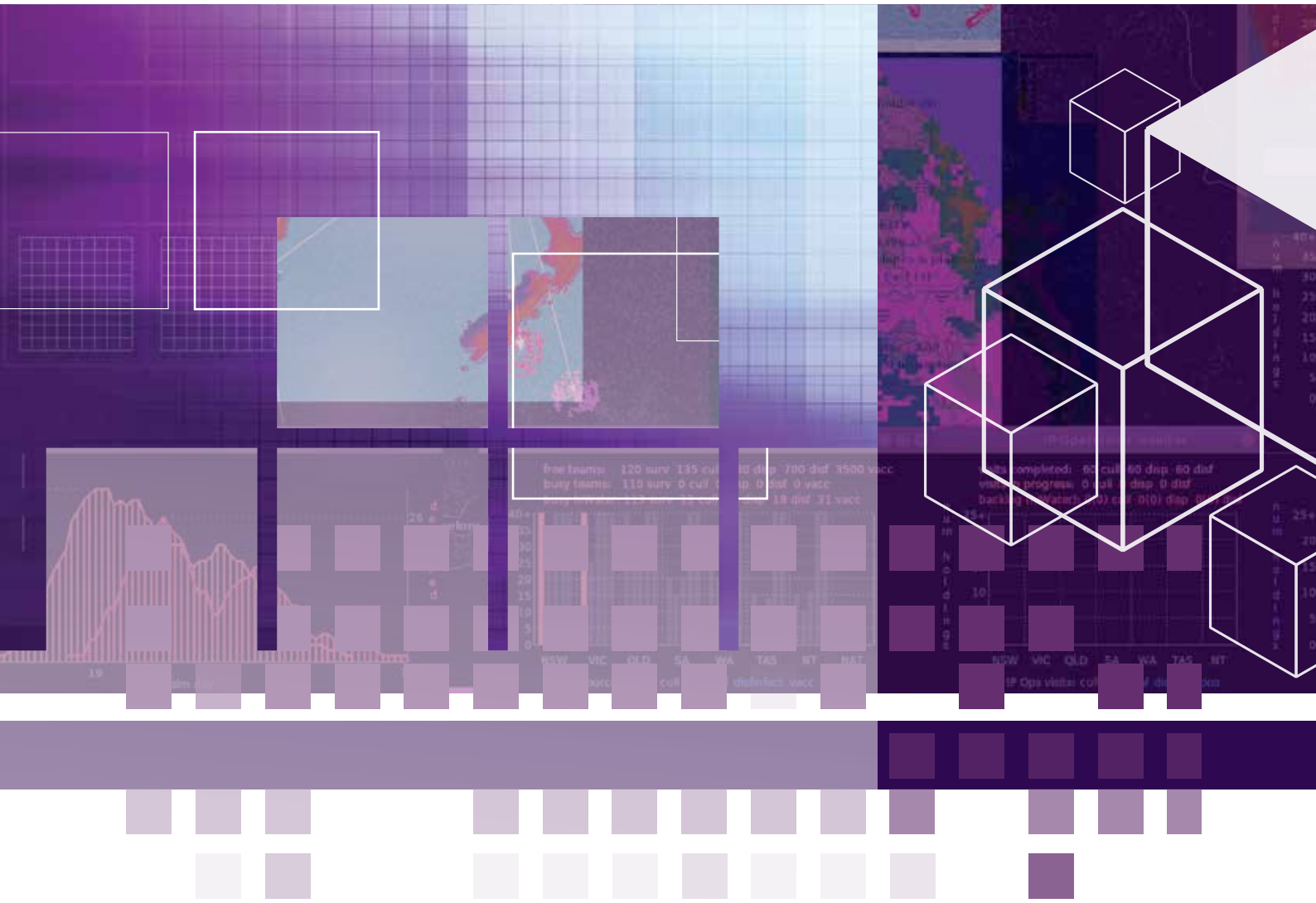
NPPP: national priority plant pest

PIO: Plant Import Operations

PLANTPLAN: Australian Emergency Plant Pest Response Plan

SAC: Scientific Advisory Committee

SRA–ANZ: Society for Risk Analysis – Australia and New Zealand



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POST

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Australian Government
Department of Agriculture

THE UNIVERSITY OF MELBOURNE

Ministry for Primary Industries
Manatū Ahu Matua

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