cebra

Centre of Excellence for
Biosecurity Risk Analysis

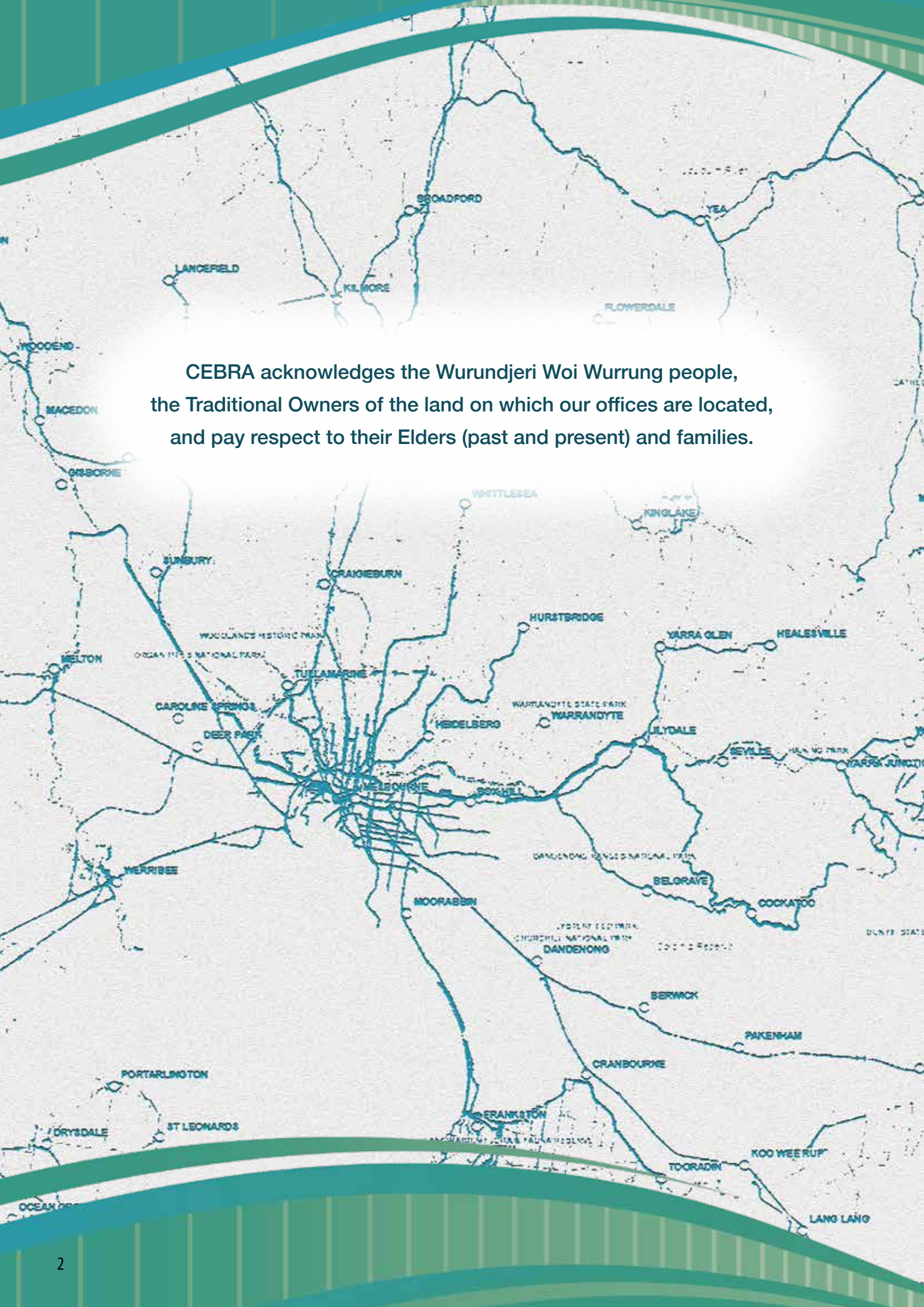
Annual Report

2023

Australian Government
Department of Agriculture,
Fisheries and Forestry

THE UNIVERSITY OF MELBOURNE

Ministry for Primary Industries
Manatū Ahu Matua



CEBRA acknowledges the Wurundjeri Woi Wurrung people, the Traditional Owners of the land on which our offices are located, and pay respect to their Elders (past and present) and families.

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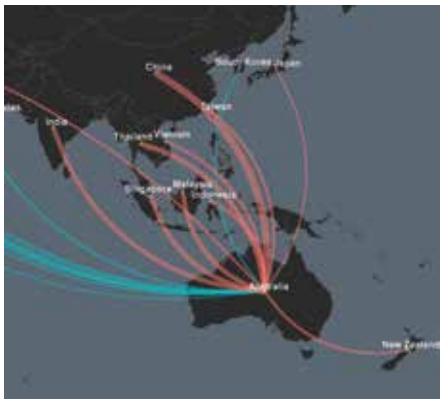
What is CEBRA?

Based at the University of Melbourne, the Centre of Excellence for Biosecurity Risk Analysis (CEBRA) is a research centre jointly supported by the university and biosecurity regulators; the Australian Department of Agriculture, Fisheries and Forestry (DAFF) and the New Zealand Ministry for Primary Industries (MPI). CEBRA supports government regulators to anticipate, prevent, screen for, prepare for, detect, respond to, recover from and adapt to biosecurity invasions.

CEBRA fosters collaboration. By sharing research and connecting stakeholders to academics from a range of disciplines, CEBRA helps drive global progress on biosecurity challenges.



What does CEBRA do?

CEBRA provides practical solutions to challenging research questions using scientific tools and techniques. Past and current research at CEBRA includes:

- supporting compliance-based intervention schemes
- optimising risk-return of inspection activities
- spatial modelling of invasive species
- evaluating the performance of the biosecurity system
- estimating the value of the biosecurity system
- designing intelligence gathering tools
- developing and applying expert elicitation protocols.

CEO's message

Welcome to the 2022–23 CEBRA annual report.

The report presents highlights of our activities for the year ended 30 June 2023. This is our second year under our grant agreement with the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) and New Zealand's Ministry for Primary Industries (MPI), in place until June 2025.

Australia and New Zealand face significant biosecurity threats that have the potential to harm the environment, agriculture, economy, and public health. These threats come from the introduction of invasive species, diseases, and pests that can disrupt ecosystems, devastate crops, and compromise native flora and fauna. These threats have implications whether they are detected in country or not. For example, the recent detection in Indonesia of lumpy skin disease in Australian cattle shortly after their arrival is a significant concern. Where did the animals contract the disease? It has never been detected in Australia, so among other things, the detection highlights the susceptibility of supply chains to possibly imperfect testing regimes. Furthermore, foot-and-mouth disease is endemic to the north-west, but, again, Australia is free of it, as are Timor Leste and Papua New Guinea. All credit to DAFF for their relentless work in protecting our borders. However, we are all too aware that every victory in biosecurity is temporary.

CEBRA plays a vital role in helping Australian and New Zealand governments remain at the forefront of practical biosecurity risk analysis by providing collaborative, relevant, innovative, and practical research outcomes. CEBRA comprises scientists from a range of disciplines, including economics, ecology, mathematics and statistics. We seek to develop and sustain a diversified view on biosecurity. Our extensive research networks allow us to call on the best scientists to fill any expertise gaps in our direct team.

Essential to success is our close relationship with governments, which enables us to work on topics that are both policy relevant and scientifically challenging. CEBRA truly values the sustained engagement of our colleagues in DAFF and MPI, particularly our day-to-day contacts. And, our impact extends internationally. We have direct connections to international regulators and support organisations such as the United States Department of Agriculture, EUPHRESCO, and the UK Department for Environment, Food and Rural Affairs.

Contributing significantly to our strong external relationships is the CEBRA Board, which includes multidisciplinary independent members and core agency representatives. I am very grateful to the Chair, Lindy Hyam, and to all Board members for their support and insights. Thanks to our scientific review panel led by Prof. Ian Robertson, Murdoch University, which helps maintain the high standards of CEBRA output. I also thank the University of Melbourne, especially the Faculty of Science and the School of BioSciences, for their steadfast support.

CEBRA has appointed Assoc. Prof. Susie Hester as Deputy CEO. Susie is an applied economist who has worked extensively on invasive species management. The tools she has designed to support policy making have helped our stakeholders immeasurably. There is information on her influential work in the project highlights section of this report.

I'm very proud that CEBRA features significantly in the prestigious Australian Biosecurity Awards, with two worthy winners. Dr Richard Bradhurst received the Dr Kim Ritman Award for Science and Innovation for his outstanding work on the development of the Australian Animal Disease Spread simulator, AADIS. The CEBRA University of Melbourne subject, Biosecurity: Managing Invasive Species, led by Dr James Camac, won the Education Award.

Every year brings new faces to the CEBRA lab. We are delighted to welcome our new business manager, Sue Tan. She is an experienced risk, operations and business management professional. Farewell and thank you to Cassie Watts, who has departed after seven years. Dr Nick Moran has also joined CEBRA, bringing research experience in invasion biology and practical experience in biosecurity management, and a welcome laconic sense of humour. And we bid farewell to Dr David Rolls, a Senior Research Fellow.

Research that is not communicated has little value. CEBRA is committed to sharing research with other biosecurity academics and practitioners and communicating the importance of biosecurity across the wider community. Thank you to all our staff for their exemplary efforts in this regard, and particularly Erica Kecorius for her communication support.

This report showcases CEBRA's important and diverse contributions to the biosecurity challenge – one that is constantly changing, with new trade patterns, shifting global alliances and a warming climate. The increasing interconnectedness of consumers and international markets means that we are now all stakeholders of, and participants in, the biosecurity system.

Professor Andrew Robinson
CEO, CEBRA

Chair's report

With the lifting of COVID-related movement restrictions, the heightened risk posed by lumpy skin disease (LSD), foot-and-mouth disease (FMD), African swine fever (ASF) and other exotic pests and diseases, and the ever-increasing focus on the impact of global warming, the CEBRA team has been active in research and advisory-related activities domestically and internationally.

The CEBRA agreement signed by the University and DAFF specifies that CEBRA should periodically provide strategic advice and guidance to DAFF and others on biosecurity trends and risks and priority areas for research investment, including new approaches and technologies. The CEBRA Board convened a horizon scanning workshop for biosecurity risk in November 2022 to elicit and share knowledge and perspectives from a range of biosecurity experts, including DAFF and MPI, on what the future may look like for the biosecurity system in Australia, with focus on risk assessment, management, and communications. This exercise aimed to provoke thinking in ways that may not have previously been considered and to identify areas where there are gaps in knowledge, such as moving away from an organism focus to look at pathways, and who gets impacted, and expanding work on behavioural economics with a longer-term focus.

Three headline ideas arose from the horizon workshop:

- Investment in biosecurity response has benefits for future biosecurity responses, including a need to think about counterfactuals and the benefits of lessons learnt (such as the implications for future responses following an eradication).
- The risks to environmental biosecurity that may be associated with the Departmental structural split between agriculture and the environment.
- The potential benefits of developing high-level generic models to enhance our response to new hazards.

Following the workshop, CEBRA convened the first regional biosecurity group, including Prof. Shaun Collin, School of Agriculture, Biomedicine and Environment, La Trobe University; Prof. Trevor Drew, Australian Centre for Disease Preparedness, Prof. Eugene Athan, Centre for Innovation in Infectious Disease and Immunology Research and Prof. Sharon Lewin, The Peter Doherty Institute, The University of Melbourne; with apologies from Ms Lee Cale, Biosecurity Operations Division; and Dr Brendan Rodoni, Department of Energy, Environment and Climate Action, Agriculture Victoria. The group discussed areas of mutual interest and opportunities for collaboration.

Information from those meetings was combined with the regular environmental scanning discussions with state and territory jurisdictions held by the CEBRA Chair and the CEO, for which we have had positive feedback. Additionally, there have been CEO meetings with First Assistant Secretaries and other senior Departmental staff to discuss strategic biosecurity risk management issues and identify project concepts. The findings have contributed to the selection of the shortlisted preliminary research proposals for 2023–24.

The CEO met with the MPI Director General, Deputy Director General and Minister, and other New Zealand stakeholders, confirming the work priority areas for CEBRA for 2023–24.

Governance

The year commenced with a review of CEBRA's Strategic Vision Statement 2021–25, which was adopted by the Board. CEBRA Board members continued to bring their knowledge and expertise to enhance discussion and decisions related to biosecurity risk, covering issues such as learning from the COVID pandemic, the future role of One Health, risks from invasive species, global megatrends, environmental impacts of climate change, and current information on LSD, FMD and Varroa mite.

Core Board Membership, 2022–23:

- Assoc. Prof. Theresa Jones replaced Prof. Margie Mayfield as the new representative from the School of Biosciences in May.
- Prof. Jodie McVernon, Doherty Institute
- Mr Terry Charlton, independent
- Ms Sarah Corcoran, Plant Health Australia, commenced in July 2022, replacing Prof. Anna Meredith.

Advisory Board members included two Department executives: Dr Robyn Martin, First Assistant Secretary, Biosecurity Animal Division, who retired and was replaced by Dr Robyn Cleland, Chief Environmental Biosecurity Officer, who then also retired and was replaced by Dr Bertie Hennecke, Chief Environmental Biosecurity Officer; Dr Peter Gooday, ABARES; Dr Michael Ormsby, MPI; Prof. Peter Taylor, University of Melbourne; Prof. Michael McCarthy, University of Melbourne; and independent, Dr Bruce Christie. We also have Prof. Ian Robertson, Murdoch University, who kindly chairs the scientific review panel.

DAFF Secretary Mr Andrew Metcalfe AO visited CEBRA in January. Following CEBRA presentations, there were discussions on strategic biosecurity risks and findings from our environmental scanning workshops. Other discussion topics included environmental biosecurity risks, engagement in One Heath, and regional biosecurity, such as for the Pacific and Biosecurity Commons.

The Board continued having visiting speakers at each of its meetings. Presenters included Dr Beth Cookson, Deputy Chief Veterinary Officer, DAFF; Dr Lloyd Klumpp, Inspector-General of Biosecurity; and Dr Shumoos Al Riyami, CEBRA.

CEBRA continued its focus on accountability, efficiency and effectiveness through the formulation and continuation of its key performance indicators. They provide a basis for regular meetings with DAFF and enable our stakeholders to track progress against the key milestones in the CEBRA grant agreement with DAFF.

The introduction of Monday.com software provides a robust and transparent project tracking system against milestones, enabling real-time reporting and a strong focus on financial management. Our scientific review panel, led by Prof. Ian Robertson, has a key role in ensuring the quality of our work by reviewing and advising on research project proposals and reports. The Board revisited our risk register to ensure good practice in managing risk.

Our greater emphasis on impact activities has resulted in increased demand for services from CEBRA by both our core and non-core partners. By undertaking additional contracted research and service projects drawing on our expertise, CEBRA builds on current and past projects and relationships with others in the biosecurity and risk analysis areas. At the end of July 2023, CEBRA had 19 non-core projects underway and 14 in various states of preparation with a range of government agencies and industries in addition to DAFF and MPI.

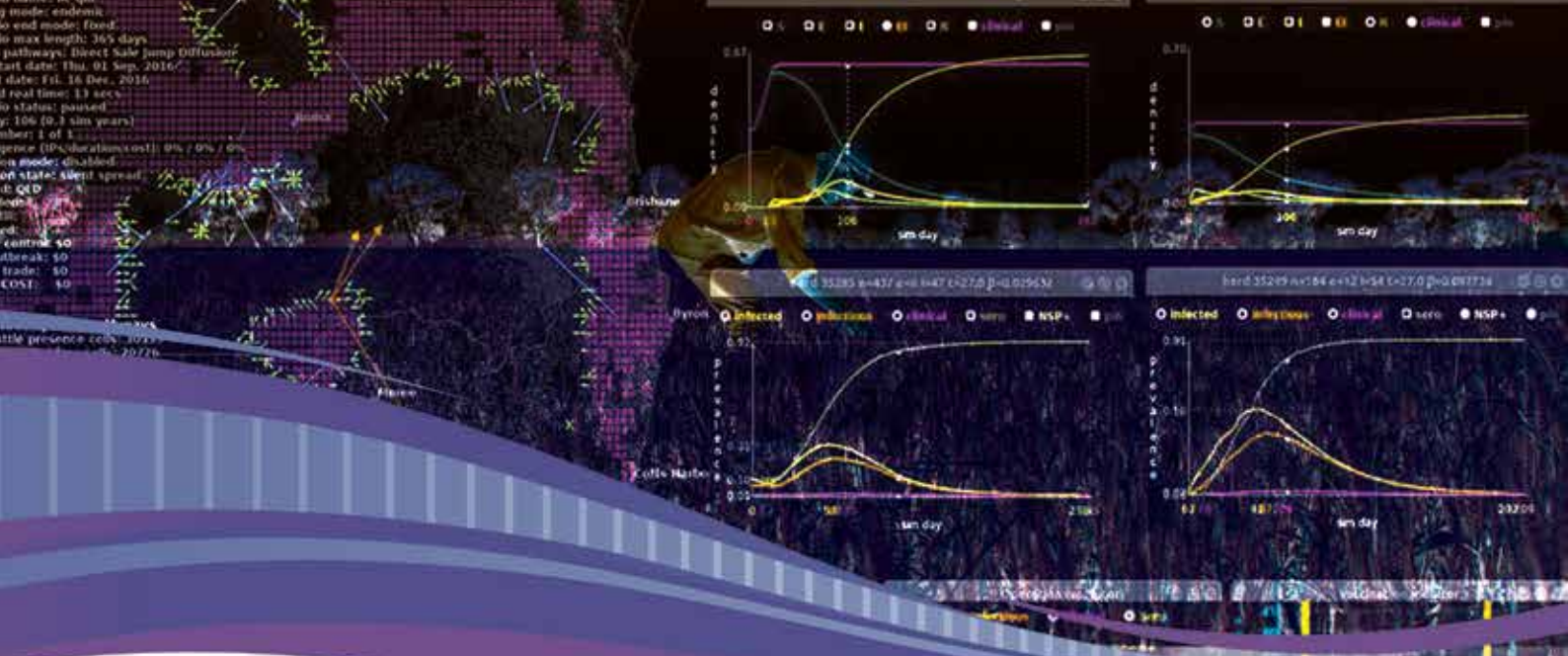
The effectiveness of CEBRA's work is critical to helping to maintain and strengthen Australia's biosecurity system, particularly as we know that biosecurity resources will remain tight. To that end, sponsoring and presenting at relevant international conferences provides exposure of our work. Examples include Prof. Tom Kompas presenting to the Commonwealth Treasury on 'Economic damages from global warming'; Prof. Andrew Robinson, our CEO, meeting with the European and Mediterranean Plant Protection Organization, Switzerland, and presenting at the International Conference on Biological Invasions, New Zealand; team members presenting at the annual meeting of the International Pest Risk Research Group in Athens; and Dr Richard Bradhurst being appointed as an advisory board member of a 5-year US$2.5 million research project ('Predicting livestock disease') awarded by the US Department of Agriculture to the University of Vermont.

CEBRA researchers have won prestigious awards. Dr Richard Bradhurst received the 2022 Dr Kim Ritman Award for Science and Innovation, acknowledging his work developing the Australian Animal Disease Spread Model. Dr James Camac and the CEBRA team received a 2022 Australian Biosecurity Award in the Education category for the University of Melbourne subject 'Biosecurity: Managing Invasive Species'.

Part of CEBRA's commitment to building the biosecurity skills base of the next generation is through our education program focussed on the processes and actions underpinning anticipation, preparation and responding to incursions drawing on expertise from world-leading biosecurity experts in industry, government and the environmental sector. There were 54 graduate students enrolled in this course in 2022 and we expect similar numbers in 2023.

I thank CEO Andrew Robinson, the Board, CEBRA team members and the various partnering organisations for their significant commitment and contribution to CEBRA throughout the year.

Lindy Hyam
Chair, CEBRA



Overview

CEBRA at a glance: 2022–23

5 DAFF research projects

11 Non core projects completed

60 presentations

7 workshops

1 MPI / DAFF project

Comparing the costs and benefits of different levels of intervention

1 MPI project

20 media engagements

2 winners at Australian Biosecurity Awards

30+ journal articles

Biosecurity risk from changes in climate, trade and pest and disease pathways

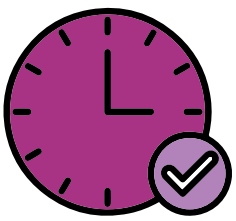
2 reports for core projects endorsed

Import policy 'health-check' framework (21G) for DAFF
and
Streamlining the risk analysis process (21L) for MPI

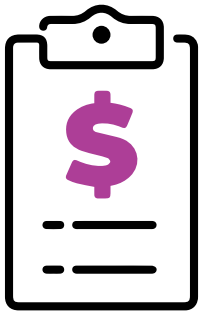
Importer incentives in regulatory design

Program performance

CEBRA are committed to delivering timely, on-budget research.
During the period 2022–23, we performed strongly against milestones.



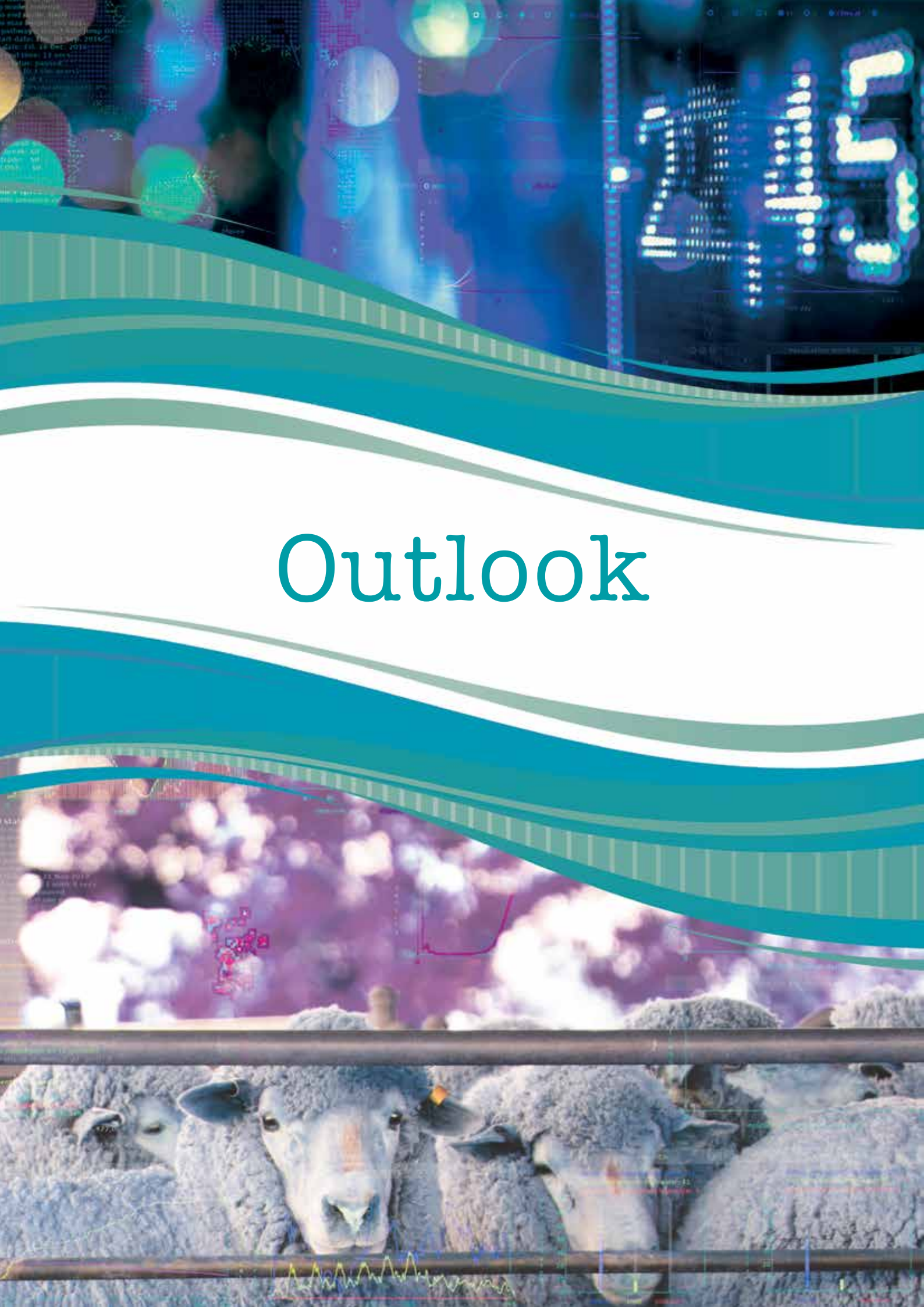
Timely



On budget

All Milestones approved

Outlook



Outlook

Protecting Australia from increasing biosecurity risks and responding to emerging threats requires constant vigilance and oversight.

New and ongoing biosecurity threats to our region include foot-and-mouth disease and lumpy skin disease, topics that feature prominently in CEBRA's research portfolio. With limited budgets, Australia and New Zealand's biosecurity systems must respond to these shifting risks using an evidence-based approach while minimising the impact on trade and tourism. CEBRA has shown the value of spending on biosecurity; every dollar invested by the Australian Government returns an estimated $30 in value from damages averted.

2022 brought a range of biosecurity challenges, with a foot-and-mouth disease outbreak in Indonesia, and lumpy skin disease and varroa mite threatening agriculture, the environment and Australia's economy. Ahead will be new and increasing challenges. These include biosecurity threats at our borders driven by increased numbers of travellers, diversifying trade and cargo, and changes in climate. There are increasing biosecurity threats, especially to our north, demanding prevention and surveillance in Australia and our neighbourhood, and improved preparedness and response.

Science and technology play a vital role in biosecurity management. Artificial intelligence and machine learning can help with myriad applications, from biosecurity documentation processing to automatic detection of the level of biofouling from photos and video. Social science, social media and citizen science will continue to contribute to surveillance and identification of threats, and to improved public and industry responsiveness. COVID helped accelerate vaccine development, presenting an opportunity to manufacture RNA vaccines for livestock, bringing us closer to the ideal of DIVA vaccines; animals vaccinated using these vaccines can be distinguished from animals infected by the disease in testing.

A new biosecurity project is set to play a transformative role in protecting Australia from plant pests, weeds and diseases. Biosecurity Commons will combine vast quantities of invasive species data and sophisticated analytical tools to indicate likely locations of diseases and pests, where they may spread, their impacts and how long they will take to eradicate. It will offer a comprehensive, highly accessible suite of functions for preparing and responding to biosecurity incidents. The project is a $1.8 million initiative between the Commonwealth and Queensland governments, CEBRA, the Australian Research Data Commons, The University of Melbourne, Griffith University, EcoCommons Australia and the Atlas of Living Australia.

Released in 2021, the Commonwealth Biosecurity 2030 roadmap seeks to create a stronger, smarter biosecurity system, responding to a rapidly changing environment to ensure that Australia has the controls, partnerships, tools, processes and networks to manage current and future threats. CEBRA is helping DAFF and MPI build on existing practices and further embed risk-based methodology into future operations.

CEBRA have continued to provide world-class research during the second year of our grant agreement (in place until June 2025) with DAFF and the University of Melbourne. With Australia and New Zealand facing ongoing challenges, the need for informative biosecurity modelling, science and economics is more pressing than ever.

CEBRA Biosecurity Research Projects

July 2023 – June 2024

(TOTAL PROJECT FUNDING: $1,770,384)

BETTER ANTICIPATE BIOSECURITY RISK

$308,148

Project ID: 23A

Project title: Short-term population forecasting of Australian Plague Locust *(Chortoicetes terminifera)*

CEBRA project lead: James Camac

Department project lead: Alan Spessa & Con Goletsos

Department project sponsor: Bertie Hennecke

2023–24: $148,000

Project ID: 23F

Project title: Assessing the potential role of feral pigs in an outbreak of foot-and-mouth disease in Australia

CEBRA project lead: Richard Bradhurst

Department project lead: Emily Sellens

Department project sponsor: Narelle Clegg

2023–24: $160,148

SYSTEM DESIGN AND REGULATORY INCENTIVES

$463,800

Project ID: 21C

Project title: Incentive-compatible biosecurity policies – a framework for regulatory design

CEBRA project lead: Susie Hester

Department project lead: Dan Presser

Department project sponsor: Bronwen Jaggers

2023–24: $191,000

Project ID: 22C

Project title: Improving DAFF's effectiveness in engaging the community about general surveillance

CEBRA project lead: Susie Hester

Department project lead: Heleen Kruger

Department project sponsor: Bertie Hennecke

2023–24: $272,800

BETTER ALLOCATE RESOURCES TO BIOSECURITY RISK

$141,840

Project ID: 23D

Project title: Quantitative model for assurance-based auditing of approved arrangements

CEBRA project lead: Andrew Robinson

Department project lead: Nick Small

Department project sponsor: Caroline Gibson

2021–22: $249,000

Project ID: 21M

Project title: Value and Health of the New Zealand Biosecurity System

CEBRA project lead: Tom Kompas

NZ Project Manager: Kasey Souness

NZ Project Sponsoring Group: Biosecurity New Zealand leadership Team

2021-24: $450,188

SYSTEM ENHANCEMENTS

$856,596

Project ID: 21E

Project title: A biosecurity risk research platform to inform decision-making

CEBRA project lead: : Les Kneebone & Andrew Robinson

Department project lead: Jessica May

Department project sponsor: Bronwen Jaggers

2023–24: $347,777

Project ID: 23B

Project title: Return on investment in international standard setting engagement: A case study on BSE status

CEBRA project lead: Susie Hester

Department project lead: Rob Atkinson

Department project sponsor: Mark Schipp

2023–24: $171,000

Project ID: 21K

Project title: Automated image analysis for identifying the biofouling risk of vessels: exploring deployment strategies and analysing video footage

CEBRA project lead: : Evelyn Mannix & Andrew Robinson

Department project lead: Bart Woodham

Department project sponsor: Chris Parker

2023–24: $71,119

Project ID: 23C

Project title: Developing a comprehensive approach to consequence estimation ('Consequence Estimates')

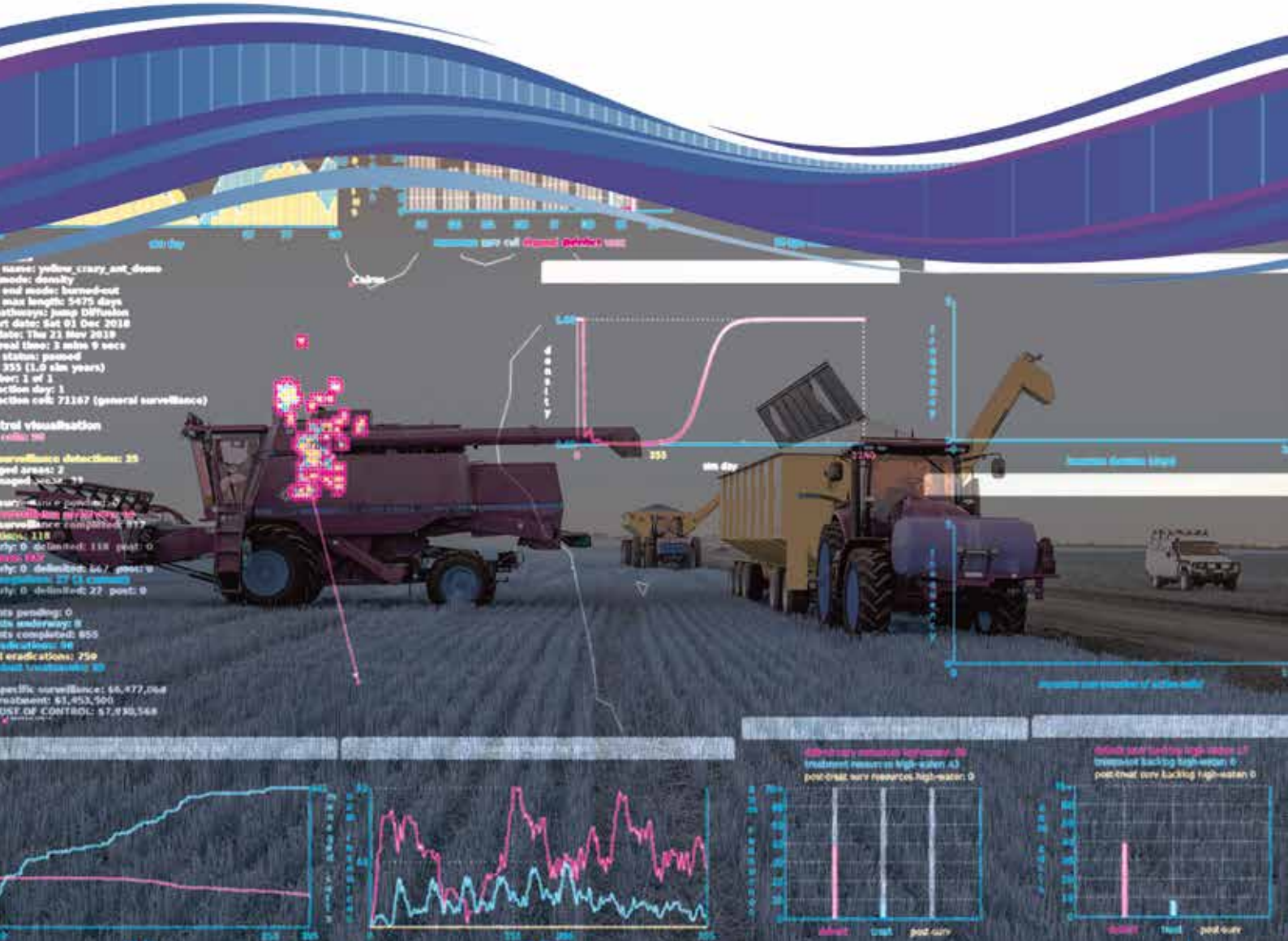
CEBRA project lead: Tom Kompas

Department project lead: Vivian Xing & Ellen Miech

Department project sponsor: Holly Buckle

2023–24: $266,700

Research



Project highlights

CEBRA is committed to producing research that makes a difference.
The following are examples of the uptake and impact of recent projects.

1. DEMONSTRATING THE VALUE OF AUSTRALIA'S BIOSECURITY SYSTEM

Value of Australia's biosecurity system (170713)

Australia's biosecurity system substantially benefits the community by managing the risks posed by exotic pests and diseases to the health of people, animals and plants, the environment and the economy. While Australia's biosecurity system is inherently valuable, it is difficult to quantify the value of the entire system. Most research focuses on estimating the cost of specific pests or disease incursions.

In collaboration with DAFF, the CEBRA project developed a spatial-temporal model to simulate the spread of 40 functional groups of pests and diseases across agriculture, environment, infrastructure and other critical assets.

The project quantified potential damages to these assets with the current biosecurity system in place and for a hypothetical scenario with no biosecurity system. The multi-year project showed that, when modelled over 50 years, the value of the biosecurity system was $314 billion in present value as at 2020, representing an average return of $30 for every dollar invested by the Australian Government.

For the first time, the Australian Government can quantify the economic benefit of the biosecurity system and the importance of sustainable investment in it. The findings have been referenced in various policy and ministerial forums.

Vivian Xing,

Director, Biosecurity Strategy and Reform Division, DAFF stated:

> "This project was a great example of a successful public and private partnership. The deep expertise required, and the multidisciplinary nature of the project mean that it would have been extremely difficult without drawing upon the research and the breadth of expertise in the academic community. This project has demonstrated the benefits and potentials of close collaboration between the Government and the academic community."

2. THE MANY APPLICATIONS OF THE AUSTRALIAN ANIMAL DISEASE SPREAD MODEL

A large outbreak of foot-and-mouth disease could cost Australia billions of dollars. Foot-and-mouth disease, African swine fever and lumpy skin disease have recently been detected in the region. Although Australia is free of these diseases, it is essential to have effective response plans, given the potential impact on animal health, society, and our economy.

Epidemiological models are a potent tool to help prepare for outbreaks. They can simulate incursions of exotic diseases at different locations in different seasons, comparing the effectiveness of candidate control strategies and likely demands on the resources required to respond.

Many of CEBRA's projects include development and applications of the Australian Animal Disease Spread Model (AADIS) (www.aadis.org). AADIS simulates the incursion, spread and control of emergency animal disease in livestock and wild populations. It has been used to investigate diseases such as foot-and-mouth, bluetongue, African swine fever and Mycoplasma bovis.

Internationally recognised, AADIS has been adapted for over 20 countries, including New Zealand, Canada, USA and across Europe. Researchers have applied the model to investigate transboundary European outbreaks; the incursion, spread and management of agricultural and environmental pests; disease in wild populations, and human disease.

AADIS has a novel hybrid modelling approach that combines analytical, agent-based, network, and cellular automata modelling techniques. It is a stochastic model that captures epidemiological uncertainty and regional and seasonal variability in transmission.

The model allows exploration of interactions between the natural world and livestock, a boundary that is becoming more complex. Another challenge is assessing how climate change might affect disease outbreaks, for example, via variations in the distribution and abundance of insect vectors.

AADIS can be used to test the cost-effectiveness of response policies, such as controlled areas and vaccination, against potential outbreaks.

Co-creator and principal developer of AADIS, Dr Richard Bradhurst, was recognised for his work in the 2022 Australian Biosecurity Awards, receiving the Dr Kim Ritman Award for Science and Innovation.

AUSTRALIAN ANIMAL DISEASE SPREAD MODEL APPLICATIONS

Using decision support tool in emergency animal disease planning and response: Foot-and-mouth disease (1404D)

Emergency vaccination can be effective in reducing the size and duration of a foot-and-mouth disease outbreak. The project describes how to infer the potential size of an outbreak and provides information to support disease management decision-making.

The project extended AADIS to examine the mitigation strategies described in Australia's contingency plans for foot-and-mouth disease.

National level farm demographic data for preparedness of highly infectious livestock disease epidemics (1402C/1502C)

The project supports emergency response planning in New Zealand through statistical models that use remotely sensed data to estimate farm animal numbers. The models have identified areas where data are sparse and uncertainty is large. The project described where additional data are needed to minimise the costs of disease incursion.

AADIS simulated disease spread within herds and farms, showing the effect of herd size on disease spread.

Decision support tools for vector (insect) spread animal disease (1608B)

While foot-and-mouth disease represents the greatest disease threat to livestock industries, Australia must be prepared for various other diseases. Arboviral diseases such as bluetongue pose significant challenges due to spread by insects. The project extended the AADIS model to simulate the seasonal distribution and abundance of insect vectors of livestock disease.

Incorporating real-time economic components in Australia's foot-and-mouth disease modelling capability and evaluating post-outbreak management to support return to trade (1608D)

The project combined epidemiological and economic expertise from DAFF and the Australian National University to establish a science-based and cost-effective approach to rapidly regaining foot-and-mouth disease-free status after an outbreak.

Researchers extended AADIS to test the effectiveness of diagnostic procedures and sampling approaches to meet surveillance requirements for regaining disease-free status.

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

This project extended the AADIS model to simulate the incursion, establishment, detection, and control of invasive species. Managing incursions requires knowledge of pest ecology and epidemiology, and surveillance data to guide zoning and implementation of control measures.

AADIS simulated natural and human-assisted spread of plant and environmental pests.

Modelling the spread and control of African swine fever in domestic and feral pigs (20121501)

Damages from a large multi-state outbreak of African swine fever could exceed $2 billion. Using Queensland as a test case, researchers adapted AADIS to simulate the spread and control of African swine fever in domestic and feral pigs. DAFF approved project expansion under the Biosecurity Innovation Program to model post-border spread and control of African swine fever nationally.

Assessing the potential role of feral pigs in an outbreak of foot-and-mouth disease in Australia (23E)

The project will extend AADIS to simulate the spread and control of foot-and-mouth disease in feral pigs and spillover transmission between feral pigs and livestock.

AADIS has also featured in the following external contract projects (described in Grants and consultancy projects):

- Modelling the spread and control of lumpy skin disease in Australia (DAFF)
- Extend AADIS-ASF model incorporating indirect transmission (DAFF)
- Modelling the incursion and spread of hitchhiker and windborne plant pests in Australia (Grains Research and Development Corporation)

3. IMPROVING ASSESSMENTS OF PEST AND DISEASE IMPACTS

Biosecurity response decision support framework (170820)

New Zealand's MPI has a framework and process for guiding decision-making in response to new pest or disease incursions that may pose a risk to economic, environmental, human health and socio-cultural values. The Ministry employs a response prioritisation tool for determining whether to act. The tool helps determine the response options and resources to allocate if action is required.

The project helped determine whether the investment in management of new incursions is commensurate with the risks posed, including risks to environmental goods and services. Led by Assoc. Prof. Susan Hester, an applied economist, the project reviewed and made recommendations on assessing pest and disease impacts using both market and non-market valuation. (Non-market valuation techniques are used to calculate the impacts of incursions when market prices are unavailable – such as the when an invasive species damages use of the environment for recreation or tourism activities, or for future generations.)

Project collaborator, Assoc. Prof. Peter Tait, created a tool to help biosecurity decision-makers apply 'benefit transfer' to assess the environmental benefits of incursion responses.

MPI is incorporating the benefit transfer tool, initiated by the CEBRA project, to support their environmental impact analyses, ordering the potential impacts of incursions across each environmental domain, and their relative magnitudes. The process represents a rigorous and defensible approach to non-market values.

Adoption of research findings is the ultimate measure of a project's success. Key to the uptake was CEBRA's co-development approach, which included workshops in New Zealand with policymakers to ensure that their needs were addressed.

4. IMPROVING IMPORT RISK ANALYSIS

Streamlining the risk analysis process (21L)

An import risk analysis assesses the risks posed by pests or diseases associated with a commodity that a country might import. Developing the analysis takes considerable time and resources. Like similar organisations, MPI had a backlog of analyses. CEBRA developed systems and technology to streamline searching, identifying, compiling, assessing, and documenting information for risk assessments. The work began with a survey of biosecurity analysts and managers at the Ministry and DAFF to determine how staff produce risk analyses and elicit their ideas to streamline the process.

MPI has implemented project recommendations, testing revised risk assessment delivery on two projects: avocado nursery stock and hops tissue culture.

The Ministry reports that the time to complete full risk assessments fell from approximately 77 to 50 hours. The Ministry estimates that with further experience, risk assessment development time will reduce to between 20 and 30 hours.

2022/23 - Project summaries

CEBRA's DAFF and MPI projects represent total funding of $1,420,746 in 2022/23

There are four themes:

- Better anticipate biosecurity risk
- System design and regulatory incentives
- Better allocate resources to biosecurity risk
- System enhancements

BETTER ANTICIPATE BIOSECURITY RISK

$358,103

Project ID: 21B

Project title: Biosecurity risk from changes in climate, trade and pest and disease pathways

CEBRA project lead: Tom Kompas and James Camac

Department project lead: Shalan Schofield

Department project sponsor: Peter Gooday

2022–23: $358,103

BETTER ALLOCATE RESOURCES TO BIOSECURITY RISK

$358,103

Project ID: 21D

Project title: Value added - modelling the marginal return on investment within and across pathways

CEBRA project lead: Andrew Robinson and Edith Arndt

Department project lead: Vivian Xing

Department project sponsor: Peta Lane

2022–23: $259,000

Project ID: 22C

Project title: Effectively engaging the community in the biosecurity system

CEBRA project lead: Susie Hester

Department project lead: Heleen Kruger

Department project sponsor: Bertie Hennecke

2022–23: 243,090

SYSTEM DESIGN AND REGULATORY INCENTIVES

$338,000

Project ID: 21C

Project title: Incentive-compatible biosecurity policies – a framework for regulatory design

CEBRA project lead: Susie Hester

Department project lead: Dan Passer

Department project sponsor: Peta Lane

2022–23: $338,000

SYSTEM ENHANCEMENTS

$222,553

Project ID: 21E

Project title: A biosecurity risk research platform to inform decision-making

CEBRA project lead: Les Kneebone and Andrew Robinson

Department project lead: Jessica May

Department project sponsor: Peta Lane

2022–23: $143,706

Project ID: 21K

Project title: Automated image analysis for identifying the biofouling risk of vessels: exploring deployment strategies and analysing video footage

CEBRA project lead: Evelyn Mannix and Andrew Robinson

Department project lead: Bart Woodham

Department project sponsor: Chris Parker

2022–23: $78,847

NZ MPI

$450,188

Project ID: 21M
Project title: Value and Health of the New Zealand Biosecurity System
CEBRA project lead: Tom Kompas
NZ Project Manager: Kasey Souness
NZ Project Sponsoring Group: Biosecurity New Zealand leadership Team
2021-24: $450,188

The following section summarises CEBRA's research projects. Projects that began in 2021 are denoted as 21X; those that began in 2022 as 22X. These seven projects represent core work under the current CEBRA funding grant agreement.

DAFF supports projects 21B, 21C, 21D, 21K, 22C.
DAFF and MPI support project 21E.
MPI supports project 21M.

21B: Biosecurity risk from changes in climate, trade and pest and disease pathways

CEBRA lead: James Camac, Tom Kompas
Sponsor: Peter Gooday, Assistant Secretary, ABARES
Project lead: Shalan Scholfield, Director, Established Pests and Weeds, Environmental Biosecurity Office
Theme: Better anticipate biosecurity risk
Budget 2022–23: $358,103
Project dates: 2021–23

Summary

Changing climate, potential new trade agreements and increasing globalisation of human movement and trade have dramatically increased the exposure of countries to pests and diseases that can have devastating economic, environmental and social impacts. This project enhances the trading partner pest exposure model developed in CEBRA project 190606 (Camac et al. 2021) by integrating it with global trade and climate Global Trade Analysis Project (GTAP) models (Kompas and Ha, 2018). This integration will provide the Department with the ability to estimate and forecast trading partner exposure risk to high threat pests and diseases under varying climate and trade scenarios. Consequently, DAFF will be better able to adapt border screening and post-border surveillance activities to mitigate threat entry and establishment risk.

Progress

Researchers have developed new temperature-related damage functions (along with ones determining losses in labour productivity from heat stress) for major agricultural sectors such as wheat, rice, maize, and soy. These damage functions have been integrated into the climate GTAP models, allowing for more realistic simulations of international import and export patterns under different climate change scenarios.

The GTAP model simulated annual international import and export trade flows for 70 regions and 40 commodity sectors under future moderate and high greenhouse emissions scenarios (known as RCP 4.5 and RCP 8.5, respectively). The model simulates changes in trade from 2014 to 2100. The project has developed a Shiny app (open source R package) to allow users to interrogate changes in trade (https://cebra-research.unimelb.edu.au/trade-dashboard/).

The original pest exposure model has been modified to work directly with annual GTAP-simulated trade-flow outputs. The model now accounts for changes in climate suitability for contamination rates and country establishment exposure. The model incorporates projected changes in global population distribution under different climate scenarios – a critical factor influencing country-level establishment exposure.

DAFF has provided CEBRA with over a decade of data on border interceptions and import inspections for all commodity and country combinations. DAFF identified five hitchhiker categories: overwintering, egg laying, nesting, sheltering, and internal storage.

In collaboration with DAFF, researchers have selected an exemplar species for each hitchhiker category:

1. Brown marmorated stink bug ***(Halyomorpha halys***), overwintering
2. Spongy moth ***(Lymantria dispar)***, egg laying
3. Asian honey bee ***(Apis cerana)***, nesting
4. Giant African snail ***(Lissachatina fulica)***, sheltering
5. Khapra beetle ***(Trogoderma granarium)***, internal storage.

For each threat, researchers have estimated exporter by commodity type contamination rates. These have been used to approximate the annual expected number of threat-specific contaminated consignments (i.e. propagule pressure) as well as establishment exposure (a relative measure that accounts for the import region's climate suitability) for 70 global countries/regions.

To maximise the utility of the model outputs, researchers have developed global interactive maps that highlight temporal patterns in how propagule pressure and establishment exposure change over time and under different climate scenarios. In addition, these interactive maps include information on the proportional risk attribution to exporter and commodity type.

The integrated model has been finalised and a final report is being prepared.

The integration of these two sophisticated models (pest pathway exposure, and global trade and climate) will provide critical outputs for other CEBRA and DAFF projects, such as pest risk mapping, import risk assessments, spread modelling and the value model.

Outlook

The project is on schedule and due for completion on 31 November 2023. The final report is due to be submitted for DAFF review by mid-September. DAFF and CEBRA have discussed extensions to the model, which may lead to subsequent projects. These extensions include:

- adding additional damage functions to the GTAP trade model (e.g. water stress and drought, more substantive sea level rise)
- incorporating functional traits into the threat exposure model (i.e. a move away from species-specific models).
- expanding the model to include passenger pathway
- integrating model outputs with existing DAFF/CEBRA infrastructure (e.g. value model, pest risk mapping and spread and surveillance models).

2022–23 milestones progress

Milestone 6: Model integration workshop	✓
Milestone 7: DAFF to provide complete pathway dataset and select threat groups	✓
Milestone 8: Climate suitability refinement	✓
Milestone 9: Model integration	✓
Milestone 10: Draft report submitted to DAFF	
Milestone 11: Department feedback to CEBRA on draft report	
Milestone 12: Submission to scientific review panel review	
Milestone 13: Incorporate review feedback	
Milestone 14: Department reviews complete	
Milestone 15: Department endorsement of final report	

Adult brown marmorated stink bug (*Halyomorpha halys*).
Photo by Alpsdake (https://commons.wikimedia.org/wiki/File:Halyomorpha_halys_s2a.jpg)

References

Camac JS, Baumgartner JB, Garms B, Robinson A, T K (2021) *Estimating trading partner exposure risk to new pests or diseases.* Tech. Rep. 190606, Centre of Excellence for Biosecurity Risk Analysis.

Kompas T, Ha PV, Nhu CT (2018) The effects of climate change on GDP by country and the global economic gains from complying with the Paris climate accord. *Earth's Future,* 6, 1153–1173. doi:10.1029/2018EF000922.

21C: Incentive-compatible biosecurity policies – a framework for regulatory design

CEBRA lead: Susie Hester
Sponsor: Peta Lane, First Assistant Secretary, Biosecurity Strategy and Reform Division
Project lead: Dan Passer (replacing Rachelle Clarke) Director, Regulatory Practice
Theme: System design and regulatory incentives
Budget 2022–23: $338,000
Project dates: 2021-25

Summary

Humans are largely responsible for the spread of pests and diseases, via air and sea cargo, mail and personal travel. To reduce biosecurity risks to Australia, DAFF imposes biosecurity regulations on people and organisations involved in these activities. Each biosecurity regulation creates an inducement (an incentive) for people to take actions that they would otherwise not consider. The effectiveness of these inducements is determined by the extent to which the behavioural changes mitigate biosecurity risks. So, in effect, human behaviour determines biosecurity outcomes.

Focusing on the incentive elements of rules and regulations is an important, and often neglected, part of designing biosecurity interventions. Detailed analysis of an intervention's impact on human behaviour is seldom undertaken. As a result, well-intentioned biosecurity interventions can cause counterproductive consequences for the environmental, economic, and societal assets they are aiming to protect.

Phase 1 of this project will provide a systematic framework for identifying vulnerabilities in biosecurity regulations and policies due to incentives and human behaviour – a tool that could be used by staff to diagnose potential or existing problems. This phase will also demonstrate the design, development and testing of an 'incentive-compatible' mechanism, and will describe a methodology for measuring the efficiency gains from an incentive-based approach to regulation design.

Phase 2 will implement the designed mechanism, either as a permanent change to a regulation or via a field pilot project.

Phase 2 will also train staff in use of the incentive-diagnostic tool to facilitate implementation of incentives in regulation design.

Progress

A systematic framework for identifying vulnerabilities in biosecurity regulations and policies due to incentives and human behaviour has been developed, and packaged as a tool. The tool's application has been explained using the companion animals' pathway. The tool includes a step-by-step diagnostic and economic framing component to enable Department staff to understand the incentives faced by decision-makers responding to a biosecurity policy. The diagnostic component frames each biosecurity pathway from a human-decision perspective. It identifies the actors involved in biosecurity, their information, motivations, interactions, actions, and biosecurity outcomes.

Depending on the complexity of the problem, the design/referral component aims to either identify refinements to the interventions or identify the mechanism and economic design skills needed to achieve more efficient and effective biosecurity outcomes. The diagnostic and referral component of the tool checks the incentive properties of biosecurity interventions —the policies, rules, regulations and inspection regimes aimed at changing human behaviour.

Development of an incentive-compatible mechanism (biofouling risk insurance) is progressing well. It is designed to provide incentives for vessel owners to reduce the biofouling of niche areas in vessel hulls to meet Australia's biosecurity requirements.

The mechanism would work as follows:

- Vessel owners will be required to purchase biofouling risk insurance, with premiums calculated by actuaries based on biofouling risks posed by vessels
- Risk ratings of vessels are linked to verifiable biofouling management plans — high risk vessels are charged high premiums, introducing an incentive to reduce biofouling risks (and pay lower premiums)
- Premium payments accumulate in an insurance pool that can fund biosecurity agency costs related to biofouling, including surveillance, and response should an incursion be detected.

The mechanism therefore provides a financially sustainable funding model.

The actuaries are undertaking a probabilistic analysis of biofouling risk via a survey of experts and published data. This analysis will be key to developing an actuarial pricing framework for biofouling risk insurance. Insurance pricing is complex and requires collaboration between actuaries, economists and marketing and legal experts. Insurance premiums should provide for all insurable costs associated with the transfer of risk.

The actuarial work is investigating two cost components of biofouling insurance: expenses associated with monitoring biofouling risk, and response losses associated with incursions.

Outlook

Year 3 of the project will focus on the incentive-diagnostic tool and the biofouling insurance mechanism, as follows:

1. Incentive-diagnostic tool

- Testing and refining the tool. There will be workshops with Departmental staff to test the tool. Current and future policies have been identified for testing. Refinement of the tool will occur following testing.
- Training. Staff will be introduced to the tool via training, likely to be via video recordings and face-to-face.
- Embedding the tool in Departmental processes.

2. Biofouling

- Risk rating methodology. The actuarial work will create a menu of incentive-compatible vessel entry contracts relevant to low- to high-biofouling risk status.
- Design the incentive structure for each contract and between contracts. The incentive structure for each vessel entry contract will be designed to encourage the vessel operator to reveal information needed to determine the biofouling risk rating. In addition, the incentive structure between contracts will be designed so that each vessel operator selects the optimal level of biofouling effort.
- Reinsurance strategy. Identify the advantages and disadvantages of government reinsurance versus commercial reinsurance options.
- Implementation. A plan for biofouling risk insurance will be developed, either as a permanent change to a regulation or via a field pilot project.

2022–23 milestones progress

Milestone 5: Workshop on draft methodology (postponed until Nov 2022)	✓
Milestone 7: Interim report for year 1	✓
Milestone 8: Draft methodology for identifying vulnerabilities	✓

21D: Value added – modelling the marginal return on investment within and across pathways

CEBRA lead: Andrew Robinson and Edith Arndt
Sponsor: Peta Lane, First Assistant Secretary, Biosecurity Strategy and Reform Division
Project lead: Vivian Xing, Director, Biosecurity System Modelling; Risk, Intelligence and Strategy Branch, Biosecurity Strategy and Reform Division
Theme: Better allocate resources to biosecurity risk
Budget 2022–23: $259,000
Project dates: 2021-23

Summary

Increases in the volume, diversity and complexity of introduction pathways threaten Australia's biosecurity system, with risk outpacing resources and new technology solutions. In response, DAFF has identified 'low-return' activities that can be reduced or stopped to free resources; however, these activities have largely been exhausted. This project seeks to develop as a proof of concept a transparent and repeatable model for comparing the costs and benefits of different levels of intervention within and across two pilot pathways.

Progress

The initial phase of the project was a user requirements analysis, working with the Biosecurity Operations and Compliance Divisions to understand the functionality required from a resource allocation tool, including how it informs decision making. The project team undertook a literature review to determine the most suitable statistical method, or combination of methods. This was followed by the development of a 'minimal reproducible example', for Divisional validation, that employed dummy data.

Work then commenced on the first of two full-scale pathway models (for sea containers) following the specification described in the user requirements and the feedback received on the minimal reproducible example.

The first step was to develop a conceptual diagram. This work was informed by the risk-return resource allocation models, the Department's instructional materials, the International Standards for Phytosanitary Measures, and collaboration with the pathway managers. The conceptual diagram of the pathway formed the basis for developing the simulation model using a Bayesian network approach. The simulation model was parametrised with Departmental import management and interception data.

The second pathway was cut flowers and foliage. The development of the simulation model followed the steps for the sea containers pathway.

Both pathway simulation models were integrated into a proof-of-concept resource allocation tool. The tool allows Departmental analysts to assess the benefits of competing strategies for allocating resources to border biosecurity risk controls. The tool consists of a user interface: a Shiny web app linked to the CEBRA value model. Users can estimate the consequences (as damages to assets) of various resource allocations.

Throughout the project, CEBRA improved the value model codebase. Enhancements include increased computational efficiency, a new workflow framework, and faster and more powerful package for raster data manipulation.

A draft final project report has been provided to the Department.

Outlook

The project is due to be completed in August 2023.

2022–23 milestones progress

Milestone 5: Draft [pilot] pathway model	✓
Milestone 6: Validation of [pilot] pathway model	✓
Milestone 7: Draft [second] pathway Model	✓
Milestone 8: Validation of [second] pathway model	✓
Milestone 9: Updates to the CEBRA value model	✓
Milestone 10: Tool	✓
Milestone 11: Draft report submitted to DAFF	✓
Milestone 12: Department feedback to CEBRA on draft report	✓
Milestone 13: Submission to scientific review panel review	
Milestone 14: Department reviews complete	
Milestone 15: Department endorsement of final report	

21E: A biosecurity risk research platform to inform decision-making

CEBRA lead: Les Kneebone, Andrew Robinson
Sponsor: Peta Lane, First Assistant Secretary, Biosecurity Strategy and Reform Division
Project lead: Jessica May, Director, Research and innovation, Biosecurity Strategy and Reform Division
Theme: System enhancements
Budget 2022–23: $344,777.28
Project dates: 2021–24

Summary

A challenge in managing biosecurity risk is to efficiently invest research effort – asking the most important questions and obtaining the best strategic advice. This project is developing a question-driven research portal based on a model of the biosecurity system.

DAFF, MPI and CEBRA will use the portal to access biosecurity research and identify gaps and overlaps.

Progress

A survey helped to define the scope of the platform content, and word inputs to a biosecurity taxonomy. Work to source, curate and transform content and metadata has been documented. There is a significant effort involved in managing multiple pipelines that access content from external libraries and websites.

2023-24 represents an implementation phase. Deliverables will include:

- additional content sources connected to the project.
- an application stack purchased, hosted and managed. Several options are being analysed as part of a hosting report.
- infrastructure hosting and associated management processes and documentation.
- stakeholder engagement and management.

Metadata profiles and guidelines to assist content suppliers will be needed. Technical pipelines will be built, monitored and updated. Metadata development, especially taxonomies (controlled vocabularies), will reflect the content and ways in which the portal is used.

2022–23 milestones progress

Milestone 6: Progress presentation (project gate)	✓
Milestone 7: Rescoping meeting	✓
Milestone 8: Generalisation of methodology	✓
Milestone 9: Outcome delivery to Department	✓

21K: Automated image analysis for identifying the biofouling risk of vessels: -exploring deployment strategies and analysing video footage

CEBRA lead: Evelyn Mannix, Andrew Robinson
Sponsor: Chris Parker, First Assistant Secretary, Animal Biosecurity Division
Project lead: Bartholomew Woodham, Marine Biosecurity Unit, Animal Biosecurity Division
Theme: System enhancements
Budget 2022–23: $78,847
Project dates: 2021–24

Summary

Biofouling is a significant source of non-indigenous marine species, causing social, environmental, and economic impacts.

In-water inspections manage the risk, but they are expensive. There is value in development of an automated system to identify and classify vessel biofouling risk.

This work builds on CEBRA project 190801, which demonstrated the viability of image analysis to automatically detect the level of biofouling. This extension is developing a methodology for more efficiently labelling biofouling imagery datasets. It is extending the models to analyse video data and developing a prototype user-interface for the Marine Biosecurity Unit.

The Department will be able to develop a business case for a product that can be incorporated into their systems.

Progress

Development of computer vision models

In collaboration with the Marine Biosecurity Unit, researchers have compiled a dataset of 55,000 biofouling images. This dataset is more diverse than that associated with CEBRA project 190801, featuring different survey methodologies.

Self-supervised learning approaches allow researchers to train models using all of this data, without requiring labelling. Models trained in this way perform better across the different datasets considered. Labelling further imagery for training results in only marginal gains. An interim report summarising these findings was provided to the Department and finalised in April 2023.

CEBRA researchers are examining how best to incorporate video data to improve the models. Frames from the videos produce 250,000 new images, which will again contain a much greater diversity compared to the earlier dataset. The challenge beyond identifying if biofouling is present in the images is to determine whether a vessel or structure is present and if the camera is above or below water. The plan is to also incorporate the previous labels to develop a comprehensive system that will also infer paint quality and identify niche areas of ships (such as lateral thruster tunnels, sea chests and propellers, that are hot spots for the accumulation of biofouling organisms).

In April 2023, Meta AI released an improved vision model called DINOv2. Researchers are exploring the methodology to determine how additional unlabelled data can improve performance.

Deployment of computer vision models

Researchers have developed a prototype user interface for the Marine Biosecurity Unit, allowing them to collaborate with companies to determine future applications of computer-vision models.

In 2021–22, the Marine Biosecurity Unit contracted Envir.ai to host the models for a trial period. Envir.ai has since been supported by Microsoft to integrate their tools into the Azure cloud. Other areas of the Department have expressed interest in having similar capability. There are ongoing negotiations with Envir.ai on model deployment.

Early in 2023, researchers identified a second potential option for deployment through SilverPond, an Australian data science company with a tool called Highlighter. A number of Australian government agencies are using this online computer vision analysis system.

CEBRA plans a trial in Darwin in August 2023 to test the computer vision models using the Marine Biosecurity Unit's underwater remotely operated vehicle. Researchers will also analyse Highlighter data to determine its suitability.

Outlook

Researchers have completed the first stage of the project, and are making timely progress on the second stage, which is to adapt models to analyse video data.

2022–23 milestones progress

Milestone 6: Development of semi-automated labelling approach	✓
Milestone 7: Report on semi-automated labelling approach	✓
Milestone 8: Provision of remotely operated vehicle video data	✓
Milestone 9: Cleaning and labelling of data in Milestone 8	In Progress
Milestone 10: Further develop methodology to apply models to video data	In Progress

21M: Value and health of the New Zealand biosecurity system

CEBRA lead: Julia Polak, Tom Kompas
NZ project sponsor: Stu Hutching, Chief Biosecurity Officer, Biosecurity New Zealand - Tiakitanga Pūtaiao Aotearoa, MPI - Manatū Ahu Matua
NZ Project lead: Michael Ormsby, Principal Adviser, Office of the Chief Biosecurity Officer, Biosecurity New Zealand - Tiakitanga Pūtaiao Aotearoa, MPI - Manatū Ahu Matua
Theme: MPI New Zealand
Budget 2022–23: $450,188
Project dates: 2021–24

Summary

This project is developing robust methods to value benefits to New Zealand of components of the biosecurity system. The project is demonstrating the value of the system, and producing a tool to test ways of improving it.

Progress

Researchers have developed a customised simulation methodology to estimate the value of New Zealand's biosecurity system in safeguarding natural, cultural and economic assets. MPI has documented the most likely and problematic pests and diseases. In collaboration with MPI, researchers have established a list of assets that biosecurity actions protect, including agriculture, forestry, Māori Customary and culture, tourism, flood control and the gene pool.

Significant progress has been achieved in quantifying the valuables and mapping their locations.

Outlook

The project is on schedule. Researchers are preparing for the expert elicitation exercise to determine the required parameters for the simulations, such as establishment rates of pests and their spread rate. By July 2024, researchers will provide MPI with an estimate of New Zealand's biosecurity system value.

2022–23 milestones progress

Milestone 1: Project start meeting	✓
Milestone 2: Data collection	In Progress
Milestone 3: Establishment of the list of hazards (pests and diseases)	✓
Milestone 4: Expert elicitation on arrival, exposure and establishment likelihoods under different biosecurity operation modes	In Progress

22C: Improving DAFF's effectiveness in engaging the community in general surveillance

CEBRA lead: Susie Hester
Sponsor: Bertie Hennecke, Chief Environmental Biosecurity Officer
Project lead: Heleen Kruger, Social Sciences, ABARES
Theme: Better allocate resources to biosecurity risk
Budget 2022–23: $243,090
Project dates: 2022–25

Summary

Understanding how to effectively and efficiently engage the community in the detection, reporting and monitoring of biosecurity threats (known as 'general surveillance') is essential for DAFF to contribute to meeting the shared responsibility goals of various recent reviews of Australia's biosecurity system. While there has been progress with understanding aspects of community biosecurity engagement , there are still knowledge gaps, including relating to general surveillance.

This project involves several phases, including an initial exploratory phase that will articulate the challenges and opportunities for DAFF staff in dealing with biosecurity engagement for general surveillance. The remaining phases of the project will improve DAFF's effectiveness in engaging the community in general surveillance. The project will develop a decision support tool for DAFF staff to enable cost-effective community engagement programs for general surveillance and robust economic evaluation of the programs.

Progress

The initial exploratory phase is complete. Interviews with DAFF staff and its general surveillance collaborators were undertaken and analysed. The qualitative analysis gives an understanding of the perspectives and needs of DAFF staff and collaborators. The analysis showed that DAFF supported at least 60 recent initiatives that enable general surveillance. The interviews revealed insights into program funding, other forms of support, what works well and the main challenges.

Outlook

The exploratory phase led to three recommendations, relating to the need to understand the impact of DAFF-funded and supported general surveillance programs. Consequently, the project will develop a decision support tool (or modify an existing tool) for DAFF staff to better understand the cost-effectiveness of various biosecurity community engagement programs. The tool would also allow routine monitoring, evaluation and reporting, helping to understand whether program goals are being met, fulfilling public accountability requirements, and supporting program improvement and resource allocation.

2022–23 milestones progress

Milestone 1: Project start meeting	✓
Milestone 2: Project gate – Understanding end user perspectives	✓

Grants and consultancy projects

The CEBRA team has participated in the following grants and consultancy projects during the reporting period. Participating in these projects expands CEBRA's knowledge and skill base, enhances engagement and builds important relationships.

Client/ Project	Start	Duration	Budget (ex GST)
Australian Research Data Commons (ARDC)	Jan 2021	2.5 years	$1.3 million
Biosecurity commons (Co-founded by ARDC, DAFF and Queensland Department of Agriculture, Water and Fisheries) Strategic biosecurity risk: development of infrastructure to host key biosecurity software, including outcomes from CEBRA projects. Builds on investment and enhances CEBRA's impact.			
Victorian Department of Environment, Land, Water and Planning & Victorian Marine and Coastal Council	Mar 2021	7+ months	$214,000
The economics of damages and the cost of adapting Victorian coastal communities to climate impacts The costs of projected damage from sea level rise and storm surge on coastal communities and coastal assets, and the relative costs of investment in adaption measures for selected cases to mitigate that damage. **COMPLETED**			
NSW Department of Primary Industries – NSW Food Authority	Apr-2021	14 months	$187,000
Development of a risk estimation tool, fast cost-benefit analysis and consequence measures to manage biosecurity and food safety Provides an Excel and MATLAB tool to allow NSW Biosecurity and Food Safety Compliance Branch to estimate the risk of a pest incursion, conduct a cost-benefit analysis and establish sound consequence measures for a potential incursion. **COMPLETED**			
SCION, New Zealand	Jul 2021	25 months	NZ$200,000
Climate change: trade and biosecurity Analyses the potential impact of climate change on New Zealand and resulting changes in pest pathways through changes in international trade. Builds on CEBRA core expertise.			
New Zealand Ministry for Primary Industries	Aug 2021	17 months (extended)	$240,000
21Q: M. bovis predictive modelling Strategic/tactical biosecurity risk: enhance the AADIS model for application to testing surveillance regimes for use by MPI upon *M. bovis*. Supports MPI in finalising world-first eradication of *M. bovis*. **COMPLETED**			

DAWE/DAFF Biosecurity Operations Division	Oct 2021	12 months	$132,500

21N: Air cargo (non-commercial) assurance program survey models
Tactical biosecurity risk: design endpoint / leakage survey to enable more efficient risk management in non-commercial air cargo. Important strategic contribution to biosecurity risk management.

COMPLETED

ARC Discovery	Nov 2021	48 months	$771,000

Nature futures: mapping pathways to prosperity for people and nature
Using a novel modelling framework and high-performance computing to integrate economic, land use and biodiversity models to evaluate policies and incentives for increasing national vegetation cover for carbon sequestration and habitat, and global risks to nature posed by land use change under future geopolitical scenarios.

ARC Discovery	Jan 2022	48 months	$642,000

Is climate change altering the carrying capacity of the world's forests?
Planting trees at a global scale can reduce global atmospheric carbon dioxide levels. However, changing climate threatens the ability of forests to be net carbon dioxide absorbers. This project aims to identify how climate will alter forest carrying capacity globally. By combining advances in forest modelling with large-scale and long-term forest inventory data, the project will develop a novel framework to forecast forest dynamics under climate change. It will provide guidelines to inform global reforestation strategies and foster climate-smart forest management.

ARC Discovery	Jan 2022	48 months	$525,000

Remote sensing of biotic stress with hyperspectral-fluorescence imaging
This project investigates new indicators of crop biotic stress using innovative airborne remote sensing and imaging spectroscopy for biosecurity applications. Satellite monitoring of crops and forests does not meet the spectral and spatial details required for early (previsual) detection of biotic and abiotic stress. The project focuses on new insights to detect the alteration of photosynthetic indicators of plant functioning, building on recent breakthroughs with airborne hyperspectral imaging and remote sensing technologies. The outcomes will provide significant benefits to Australia in the detection of harmful diseases and improved water and nutrient monitoring methods.

DAFF	Feb 2022	7 months	$184,000

22A: Sea cargo postcode classification review
Tactical biosecurity risk: develop algorithms for risk-based classification of domestic locations to enhance management of the biosecurity risk presented by shipping containers. The project represents an important analytical contribution.

COMPLETED

ACIAR	Mar 2022	8 months (extended)	$150,000

Valuing the contribution of ACIAR to biosecurity in Australia and overseas
Establishes a methodology to evaluate ACIAR's work in the Indo-Pacific region to enhance biosecurity, food security and help adapt to the impacts of climate change. The project will help establish an ongoing relationship with ACIAR and assist with their biosecurity measures.

COMPLETED

DAFF	Apr 2022	15 months	$275,000

Extend AADIS-ASF model incorporating indirect transmission
Strategic/tactical biosecurity risk: enhance the AADIS model to include indirect transmission of Australian swine fever associated with vehicles transporting pigs to and from abattoirs, improved tracking and reporting of infected animals going to non-farm destinations such as abattoirs and export facilities, and expanded surveillance and control options for feral pigs to better align with AUSVETPLAN. The project builds on investment and enhances CEBRA's national standing.

DAFF	Apr 2022	13 months (extended)	$258,000

22B: Increase the efficiency and transparency of biosecurity risk management of sea containers and their cargoes
Tactical biosecurity risk: identifying appropriate intervention rates, providing a sustainable balance between heightened measures targeted at the highest risk pathway and reduced or streamlined measures for compliant/lower risk pathways.

COMPLETED

Australian Pork Limited	Apr 2022	16 months	$57,000

Camera trap assessment of feral pigs; Understanding feral – domestic pig interactions
The proximity of feral pigs to domestic piggeries presents a strong potential for transmission of exotic disease such as African swine fever and foot-and-mouth disease, as well as endemic diseases of concern. There is limited Australian data on contact rates and the likelihood of disease transmission between feral pigs and domestic pigs. A directed study is required to better understand the direct and indirect interactions between feral pigs and domestic pigs that could lead to disease transmission.

Zespri	Jul 2022	8 months	NZ$74,000

System-level surveillance for kiwifruit producers
Strategic risk: support New Zealand kiwi fruit growers by developing a system-level surveillance system that focuses on supply chains and threat vectors. The project represents an excellent collaboration opportunity, with outcomes that will be valuable for other industries.

DAFF	Sep 2022	15 months	$401,000

Modelling the spread and control of lumpy skin disease in Australia
Strategic biosecurity risk: This proposal adapts the AADIS model to simulate the spread and control of lumpy skin disease in Australia to better understand the conditions under which it may spread and establish. Additionally, the model will compare different control strategies, including vaccination, to assist and better inform response policies and vaccination strategies.

Biosecurity Tasmania	Sep 2022	13 months	$388,000
21O: Review of border processes Strategic biosecurity risk: support Biosecurity Tasmania by assessing the policy and practice of border intervention across five pathways. Outcomes will enhance CEBRA's impact with biosecurity system stakeholders and will be valuable for other jurisdictions.			
Avocados Australia Limited	Mar 2023	20 months	$140,000
Avocado industry biosecurity strategy 2022–26 On-farm biosecurity practices and economic consequence measures for pests and diseases affecting the avocado industry.			
City of Melbourne	Mar 2023	2 months	$55,000
Canopy growth modelling using changes in canopy area data The City of Melbourne seeks to use a recently derived dataset of canopy extent through time (a 20-year period) measured for 38,000 trees to generate species-specific growth curves.			
Agriculture Victoria	May 2023	2 months	$38,000
Economic analysis – Project 1 Supply advice to the Data Analytics Unit of Agriculture Victoria on the economic analysis of shared responsibility initiatives.			
Agriculture Victoria	May 2023	2 months	$43,000
Methodology design – Project 2 Supply advice on the design of an evaluation methodology for assessing economic value of shared responsibility initiatives.			
Food Standards Australia New Zealand	Jun 2023	3 months	$25,000
Expert elicitation for the attribution of food commodity/pathogen pairs The project seeks to estimate the attribution of foodborne illness costs to food commodity groups in Australia, a topic that is only partially understood. If available, such information could be used to prioritise resources for research, monitoring and surveillance activities, and standards development**.**			
Grains Research and Development Corporation	Jun 2023	12 months	$345,000
Modelling the incursion and spread of hitchhiker and windborne plant pests in Australia Pests such as khapra beetle, brown marmorated stink bug and fall army worm pose major threats to Australia's agriculture. Forming overarching surveillance and response policies for exotic agricultural pests is challenging, given species diversity, arrival scenarios and spread modalities. Models can provide helpful decision support through the exploration of incursion points, spread pathways, detection scenarios and response options across time and space.			

Research initiative

Structured expert judgement: lumpy skin disease

Structured expert judgement is an internationally-recognised process to support decision-making when obtaining definitive information is too slow, too expensive or impossible. It is a systematic approach that minimises individual and group cognitive biases and assumptions. CEBRA uses the IDEA protocol, standing for Investigate, Discuss, Estimate, Aggregate, named after its high-level steps.

The IDEA process involves recruiting a diverse group of experts, briefing them on a series of questions, and asking them to independently investigate and provide preliminary answers. The research team anonymises and summarises the answers, presenting them back to the experts. The experts discuss the questions, identifying perspectives and points of disagreement. They then privately determine the answers and the uncertainty associated with them. Finally, the research team aggregates the expert answers to reach an overall outcome.

CEBRA has undertaken three rapid structured expert judgement exercises investigating the probability of an outbreak of specific exotic animal diseases in Australia during the subsequent five years. The participating experts came from industry, the federal government, state governments, CSIRO, and the private sector.

An initial exercise in March 2021 involved 16 experts considering the probability of outbreaks in Australia of four diseases: foot-and-mouth disease, lumpy skin disease, African swine fever and African horse sickness.

The spread of lumpy skin disease in south-east Asia led to a follow-up exercise in April 2022, with 20 experts updating the outbreak probability for that disease. In June 2022, 20 experts updated the estimate for foot-and-mouth disease.

The exercises revealed insights into factors that may affect the probability of an outbreak, such as trade activity and border controls.

Results from structured expert judgement exercises should be interpreted with care. Findings depend on the mix of experts involved and often include significant variability.

There is an estimated **3 to 4-fold increase** in the expected probability of a LSD outbreak in Australia in the following 5 years compared to a separate exercise 1 year ago

SEJ March 2021

8%

probability of an LSD outbreak in Australia in the next five years *(range: 0 – 22%)*

Map: LSD outbreaks 2019 – 20 (OIE)

SEJ April 2022

28%

probability of an LSD outbreak in Australia in the next five years *(range: 4 – 56%)*

Map: LSD outbreaks 2021 – 22 (OIE)

Subsequent structured expert judgement exercises in 2021 and 2022 showed a significant increase in estimated probability of a particular disease outbreak in Australia

Publications

As a member of the academic community, where practical, CEBRA endeavours to share research through peer-reviewed research papers. This ensures our contributions are available to, and scrutinised by, a wide range of interested parties.

In 2022–23, CEBRA staff published over 30 peer-reviewed publications.

H-index

The h-index measures the cumulative impact of the output from a researcher or organisation. The measure combines an assessment of quantity (number of papers published) with quality (impact, or paper citations).

As at 8 August 2023:

- CEBRA's h-index: 51
- ACERA's h-index: 73
- Combined ACERA/CEBRA h-index: 95

Impact factor

The impact factor is a measure of the frequency with which the average article in a journal is cited in a particular year or period. The InCites impact factor in Table 1 is calculated as the number of current year citations of items published in a journal, divided by the number of items published in that journal during the previous two years.

There is a full list of CEBRA publications at: https://overview.cebra.unimelb.edu.au/research-output-searchable-database.html

Table 1: CEBRA publications summary with average citations and InCites impact factor as at 8 August 2023

Calendar year	Total publications	Total citations	Average citations	Average InCites impact factor	CEBRA project-specific publications
2022	25	126	5.04	3.32	2
2021	28	115	4.11	6.22	2
2020	20	906	45.3	5.12	2
2019	18	437	24.28	5.82	6
2018	26	870	33.46	5.3	8
2017	37	2095	56.62	4.95	14
2016	29	1734	59.79	5.39	8
2015	29	2122	73.17	7.87	12
2014	16	1155	72.19	7.41	3
2013	27	9564	354.22	6.38	11
Total	**255**	**19124**	-	-	**68**

Reports

CEBRA staff regularly prepare reports describing research and impacts. There is an extensive list of articles published in peer-reviewed journals, books and book chapters, software, and technical reports at https://overview.cebra.unimelb.edu.au/research-output-searchable-database.html.

Surveillance system for *Mycoplasma bovis*

M. bovis is a bacteria that affects dairy and beef cattle. Infection can cause mastitis, respiratory disease, and lameness.

CEBRA researchers have worked closely with epidemiologists from MPI to develop a decision support tool that assesses the sensitivity of their background surveillance system for *M. bovis*. The tool is an adaptation of the Australian Animal Disease Spread Model (AADIS) (www.aadis.org), and allows MPI to assess different serological and bulk tank milk testing regimens with respect to system sensitivity and cost effectiveness.

Bradhurst R., Burroughs A., Crosbie A., Firestone S., Stevenson M., & Robinson A. (2022). *Development and outputs of an epidemiological model to assess the sensitivity of the New Zealand background surveillance system for M. bovis*. Technical Report prepared for MPI, 81 pages. CEBRA, University of Melbourne. http://hdl.handle.net/11343/330180

See also the presentation: Burroughs A. (7 December 2022). *Are we there yet? Determining the evidence required to demonstrate Mycoplasma bovis eradication from Aotearoa*, One Health Aotearoa Symposium 2022, Wellington, New Zealand. http://onehealth.org.nz/wp-content/uploads/2023/01/Burroughs-OHA-2022.pdf

Economic impacts from sea level rise and storm surge in Victoria, Australia over the 21st century

This was an additional activity led by Prof. Tom Kompas for the Victorian Marine and Coastal Council. The University of Melbourne and Climate Risk Pty Ltd modelled the damage and potential economic cost of sea level rise and storm surge on Victoria's bays and coastal and marine areas if adaptation measures are inadequate.

The report received extensive media coverage.

(See https://www.marineandcoastalcouncil.vic.gov.au/resources/vmacc-reports)

PhD students

CEBRA supports students, building biosecurity skills and knowledge for the future.

Evelyn Mannix

Supervisors: Andrew Robinson and Howard Bondell

Working title: Active, self and semi-supervised learning: label efficient approaches and the cold-start learning problem

Summary

Supervised deep learning approaches benefit from having large amounts of labelled data to train models. However, labelling large datasets with sufficient quality is a challenge in many computer vision machine learning projects. Large datasets or complex labelling requirements can limit opportunities to apply these technologies. This is a problem in biosecurity, where there may be few experts and limited resources. New approaches in self-supervised and semi-supervised learning are achieving promising results. These methods use a small number of labelled examples with the rest of the unlabelled data to obtain results that are comparable with supervised learning approaches. However, the practitioner must decide which images should be labelled first. Solving this 'cold-start learning' and identifying the most informative data examples to consider first would allow machine learning models to be more easily trained.

Gouri Mondal

Supervisors: Tom Kompas, James Camac

Working title: Assessing extreme poverty reduction approaches: the case of the 'graduation approach' in Bangladesh fisheries

Summary

Entrenched extreme poverty is one of the crucial global challenges affecting the livelihood of fishers. It has significant impacts on economic productivity. Various approaches, strategies, methods and tools are applied to reduce poverty. However, there is no comprehensive review of them. This research includes a systematic literature review to compare the approaches. The study will assess contributing climatic factors and the changing pattern of fisheries management practices to reduce poverty. Then, a case study of small-scale Bangladesh fishers will help understand the efficacy of different strategies. Finally, the sustainability of the socioeconomic conditions of fishers' communities will be checked via economic projections.

Madalene Oberin

Supervisor: Richard Bradhurst (co-supervisor)

Working title: A camera trap study of feral pigs to better understand the risk of transmission of African swine fever between feral and domestic pigs

Summary

African swine fever, a contagious viral disease of pigs, is an ongoing threat to Australia's pork industry. While African swine fever has not been detected in Australia, it has spread across Europe and Asia. There is uncertainty about the role that feral pigs play in outbreaks. Australian Pork Limited has provided a $41,000 grant to support a camera trap study to better understand the epidemiological interface between domestic and feral pigs. This project will help characterise feral-domestic pig interactions and inform the parameterisation of the AADIS African swine fever epidemiological model. Additionally, the study will produce a reproducible methodology for pork enterprises to implement camera trap surveillance. The camera trap study is being undertaken in Queensland, which has a large feral pig population. Collaborators on this project are the University of Melbourne Veterinary School, CEBRA, the University of Sydney, Australian Pork Limited, Biosecurity Queensland, NSW Department of Primary Industries, SQ Landscapes, and the SunPork Group.

Christine Li

Supervisors: Tom Kompas, James Camac and Ary Hoffmann

Working title: Sustainable intensification of agriculture: understanding the potential and limitations of crop diversification strategies

Summary

Sustainable intensification of agriculture is a broadly defined goal to meet growing global crop demand while achieving minimal environmental impacts in food production. The way in which the concept is defined is an open question that requires quantitative assessment at local, regional and global scales. This work explores the potential of crop diversification strategies, designed to enhance biodiversity in agroecosystems, to meet the goal. The study draws on the planetary boundaries framework to contextualise the environmental impacts of diversification practices relative to conventional agricultural practices, and to account for the non-linear effects of sustainable practices on nutrient flows and freshwater availability.

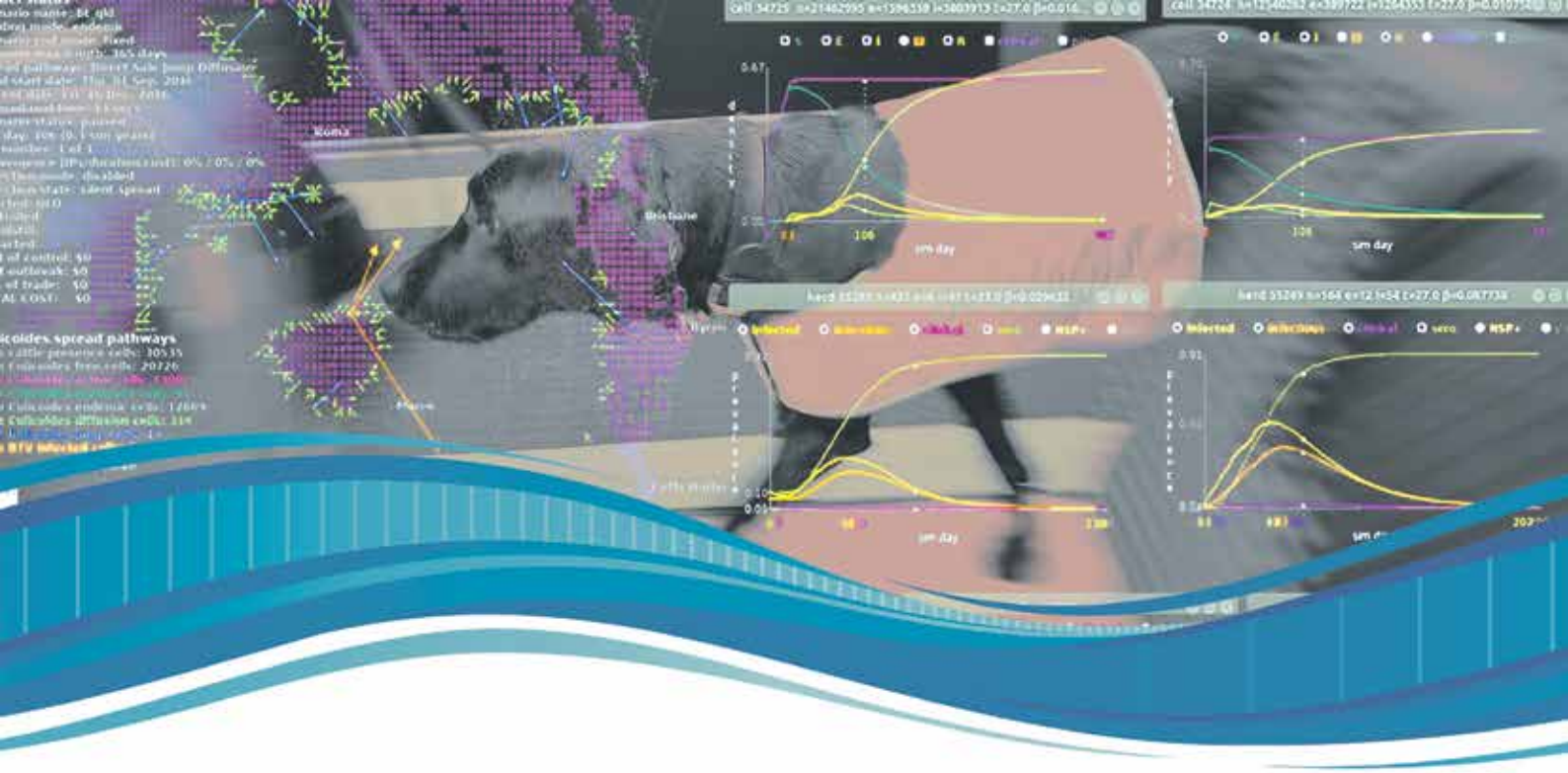
Vito Avakumović

Supervisors: Tom Kompas, Hermann Held, James Camac

Working title: Towards an integration of global warming-induced impacts in cost-risk analysis

Summary

Cost risk analysis is a decision-making framework developed as a response to the shortcomings of two approaches in climate economics: cost-effectiveness analysis and cost-benefit analysis. Cost risk analysis incorporates the cost-effectiveness analysis target-based approach associated with uncertainty in modelling global warming impacts while maintaining the mathematical structure of cost-benefit analysis. Therefore, cost risk analysis can deal with anticipated future learning. However, cost risk analysis does not incorporate consolidated impact information. Furthermore, it has been used only in the context of global mean temperature or regional climate correlates thereof within a single integrated assessment model (MIND). One focus of the thesis is to incorporate climate damage knowledge into the precautionary approach of cost risk analysis and examine its practicality as a framework beyond climate policy. Another focus of the thesis is clarifying where cost risk analysis represents a difference from probabilistic versions of cost-effectiveness analysis.



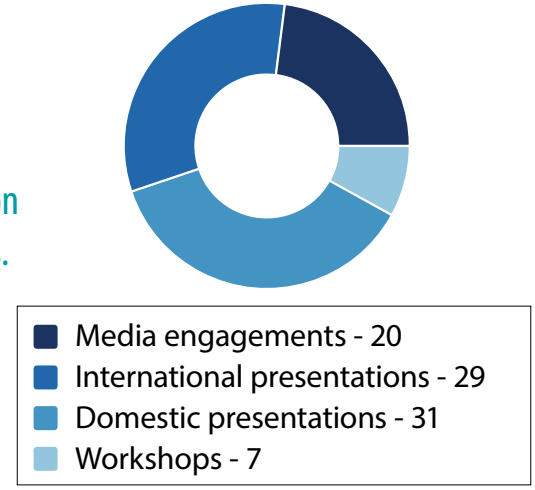
Communication and engagement

Events and media engagements

CEBRA work is regularly shared and communicated at domestic and international conferences, symposiums and other meetings.

During 2022–23, CEBRA staff members gave presentations in person and online, ran workshops, chaired sessions and featured on panels.

CEBRA researchers also shared insights with a wider audience through media engagement.



Awards

The Australian Government recognises significant commitment to the nation's biosecurity system through the Australian Biosecurity Awards. Each year, DAFF celebrates Australians who have contributed to our world-leading biosecurity system.

CEBRA featured in two of the prestigious 2022 awards.

Dr Richard Bradhurst received the Dr Kim Ritman Award for Science and Innovation. Dr Richard Bradhurst is the co-creator and principal developer of the Australian Animal Disease Spread Model (AADIS).

Epidemiological models are a potent tool to help prepare for outbreaks. AADIS helps better understand the complex epidemiological interface between domestic and wild populations. AADIS has a novel hybrid modelling approach that combines mathematical, agent-based, network, and cellular automata modelling techniques. It is a stochastic model that captures epidemiological uncertainty and regional and seasonal variability in transmission.

The CEBRA University of Melbourne subject, Biosecurity: Managing Invasive Species received the Education Award. The subject is coordinated by the CEBRA team: Dr James Camac (lead), Dr Edith Arndt, Dr John Baumgartner, Dr Aaron Dodd, Associate Professor Susan Hester, Professor Tom Kompas and Professor Andrew Robinson. The team is highly regarded for their commitment to the subject, instilling passion and enthusiasm about biosecurity in their students.

The subject is designed to prepare the next generation of biosecurity practitioners to deal with emerging challenges, from climate change to increasing globalisation of human movement and trade. It covers the processes and actions comprising an effective biosecurity system, from how to anticipate incoming risk through to how to prepare and respond to pest and disease incursions.

Dr Richard Bradhust with **Senator the Hon. Murray Watt**, *Minister for Agriculture, Fisheries and Forestry,* receiving the Dr Kim Ritman Award for Science and Innovation

Biosecurity book

A forthcoming book summarises more than 15 years of work by biosecurity specialists from CEBRA and its predecessor, the Australian Centre of Excellence for Risk Analysis.

Biosecurity: A systems perspective describes the tools, methodologies and frameworks for addressing biosecurity problems. Economic principles can guide efficient allocation of budgets and the design of policies that lead to desired stakeholder behaviour. There are descriptions of tools for understanding spatial spread of pests, and approaches to monitoring and evaluating the effectiveness of biosecurity actions.

Written for graduate students and biosecurity practitioners, the book demonstrates how to create efficient and resilient biosecurity systems by taking a whole-of-system perspective. Successfully addressing ever-evolving biosecurity challenges will require a shift away from the incremental approaches commonly used by biosecurity agencies towards approaches that are more agile, evidence-based, multidisciplinary, and logistically and commercially practical.

Expected publication date: December 2023.

Horizon scanning workshop

In November 2022, CEBRA hosted a workshop to elicit and share knowledge and perspectives from experts on the future of Australia's biosecurity system, focussing on risk assessment, management and communication. Over 30 people attended, in person and online.

The workshop spawned numerous ideas and proposals. The positive response from participants has encouraged CEBRA to plan a similar event.

International Conference on Biological Invasions

CEBRA researchers were prominent at the International Conference on Biological Invasions, held in May 2023 in Christchurch, New Zealand.

The CEBRA presentations were:

Biosecurity and pathways into Aotearoa New Zealand: relating biosecurity detections to tourism,
Prof. Andrew Robinson

Anthropogenic risk pathways for marine disease in New Zealand,
Assoc. Prof. Anca Hanea

Developing a mathematical model to evaluate biosecurity inspection policies at the border,
Dr Chris Baker

Modelling emerging biosecurity threats: choosing complexity is not so simple,
Isobel Abell

Cold PAWS: Exploring the effectiveness of label-efficient deep learning approaches in biosecurity applications,
Evelyn Mannix

Biosecurity research portal: connecting key questions to research,
Les Kneebone

Optimal post-border surveillance against invasive pests to protect a valuable nature reserve and island asset,
Prof. Tom Kompas

The value of New Zealand's biosecurity system,
Dr Julia Polak

Funding biosecurity systems efficiently, fairly and sustainably,
Assoc. Prof. Susie Hester

Biosecurity: A systems perspective*, a new book on effective management across the biosecurity continuum,*
Sana Bau

Is this 'low risk' pathway truly low risk? A risk-based sampling approach,
TK Le

Seminars

CEBRA and DAFF host regular webinars ('CEBRAnars') to showcase work and communicate research with a broad audience.

Recordings of these webinars are available on CEBRA's YouTube channel (accessible via CEBRA's website).

28 July 2022:	***The use of rubrics and other methods in qualitative evaluation***, Dr Edith Arndt
25 Aug 2022:	***Using damage functions to estimate consequences from pests, diseases and climate change,*** Christine Li
29 Sept 2022:	***Inventing biosecurity insurance: Using incentives to sustainably fund biosecurity,*** Assoc. Prof. Susie Hester
27 Oct 2022:	***Damages from climate change and changes in trade and pest pathways,*** Prof. Tom Kompas
24 Nov 2022:	***Modelling the spread and control of African swine fever in domestic and feral pigs,*** Dr Richard Bradhurst
30 Mar 2023:	***Protecting valued assets: implications for biosecurity risk analysis,*** Prof. Andrew Robinson
25 May 2023:	***Quantifying pathogens' risk of arrival and spread – a multivariate probabilistic perspective,*** Assoc. Prof. Anca Hanea
29 June 2023:	***Leveraging incomplete data for better profiling,*** Evelyn Mannix

Visiting fellow

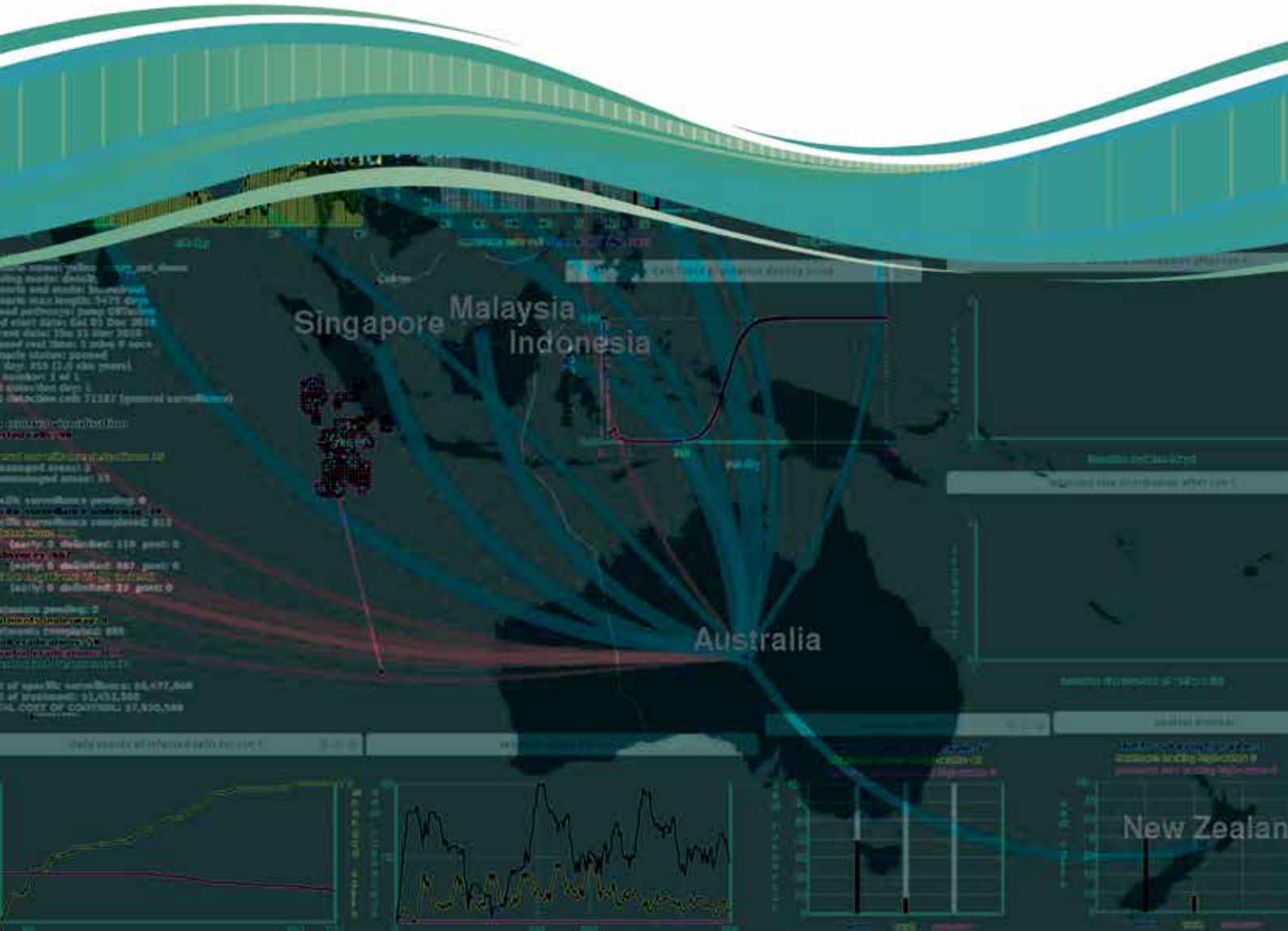
Funded by the Russel and Mab Grimwade Miegunyah Fund, the Miegunyah Distinguished Visiting Fellowship Program supports extended visits to the University of Melbourne by eminent international academics.

In 2022, CEBRA hosted a visit by Philip Hulme from Lincoln University, New Zealand. Prof. Hulme is the Distinguished Professor of Plant Biosecurity and Director of the Centre for One Biosecurity Research, Analysis and Synthesis. He is renowned for his innovative insights and research into biological invasions and biosecurity.

Prof. Hulme gave a presentation on 'One Biosecurity', advocating a coordinated global response to growing biosecurity risks to animal, plant and environmental health. The lecture covered the importance of risk assessment in biosecurity, and emerging threats from urbanisation, climate change, agricultural intensification and increased human movement.

(See a recording of the presentation at https://www.youtube.com/watch?v=DFDPcOsuHY0&t=37s)

Governance



CEBRA Board

The CEBRA Board provides advice on the operations of the Centre to the CEO on the research and policy framework. The Board also oversees the application of relevant professional standards, the progress and performance of research and outcomes, the dissemination of knowledge and the promotion of the Centre. The Board is representative of broad-ranging interests.

Board members 2022–23

Chair

Ms Lindy Hyam	Independent

CEO

Prof. Andrew Robinson	CEBRA, The University of Melbourne

Core members

Prof. Jodie McVernon	Doherty Institute, The University of Melbourne
Mr Terry Charlton	Independent
Prof. Margie Mayfield [1]	BioSciences, The University of Melbourne
Assoc. Prof. Therésa Jones	BioSciences, The University of Melbourne
Ms Sarah Corcoran	Plant Health Australia

Advisory members

Dr Bruce Christie	Independent
Prof Michael McCarthy	Ecosystem and Forest Sciences, The University of Melbourne
Prof Ian Robertson	School of Veterinary Science, Murdoch University (Chair, CEBRA scientific review panel)
Prof Peter Taylor	Mathematics and Statistics, The University of Melbourne

DAFF advisory members

Dr Robyn Martin [2]	First Assistant Secretary, Biosecurity Animal Division
Dr Robyn Cleland [3]	Chief Environmental Biosecurity Officer
Mr Peter Gooday	ABARES
Dr Bertie Hennecke	Chief Environmental Biosecurity Officer

MPI New Zealand advisory members

Dr Michael Ormsby	Biosecurity, New Zealand

[1] Stepped down in May 2023
[2] Stepped down in August 2022
[3] Stepped down in February 2023

Scientific review panel

The scientific review panel reviews and approves all draft project plans and provides an assessment of all final reports.

Role

Assist the CEO in evaluating research proposals based on:

- scientific and practical merit for risk analysis
- capacity/capability to deliver
- budget viability.

Obtain peer reviews of final reports prior to submission to DAFF or MPI for endorsement.
Provide advice to researchers conducting CEBRA projects, as requested by the CEO.

Composition

Chair: Professor Emeritus Ian Robertson

A broad group of members covering relevant fields of environmental, animal and plant sciences, biosecurity, mathematical and social sciences, psychology, philosophy and statistics.

Responsibilities of panel members

Chair will seek advice and peer reviews from suitable panel members and other colleagues on proposals, interim and final reports, as appropriate. Reviews will be forwarded to investigators for their consideration.

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 panel.

Chair will attend CEBRA board meetings to report on review panel matters.

Most of the business of the scientific review panel is conducted electronically. Formal meetings may be called at the discretion of the Chair in consultation with the CEO. The panel is supported by CEBRA administrative staff.

Key performance indicators

We measure our activities against a range of key performance indicators, to ensure that we are on track. This is a broad overview only (see appendix for details).

The measures are

- Stakeholder engagement
- Research and development
- Collaboration
- Excellence
- Governance
- Monitoring and evaluation

1. Core stakeholder engagement

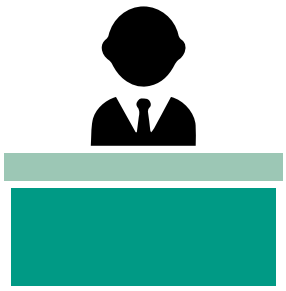
Engage core stakeholders to identify research, development and extension (RD&E) priorities and activities that are expected to provide benefits to Australian and New Zealand biosecurity, and provide strategic advice and guidance on biosecurity trends and risks, and priority areas for research investment (including new approaches or technologies).

Outcomes

4 Board meetings	13 Environmental scan meetings
19 DAFF secretariat briefings	
4 DRISC meetings	2 SAP meetings
2 yearly stakeholder survey commencing Sept 2023	

3 progress reports

2022-23 work plan approved



CEO present at DRISC and SAP meetings

2. Research, development and extension activities

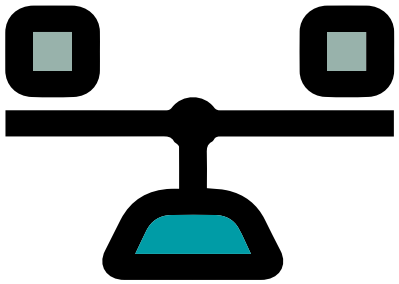
Ensure that RD&E activities, including rapid response to critical biosecurity situations, provide benefits to Australian and New Zealand biosecurity. Balance long-term, short-term, high and low risk, and strategic and adaptive research activities. Demonstrate impact.

Outcomes

6 DAFF and MPI project	2 MPI projects

Projects align with Biosecurity 2030 priority areas

Budget spread across priority areas



Projects balanced across long-term, short-term, high- and low-risk, strategic and tactical activities

Rapid response to emergent issues: Foot-and-mouth disease, lumpy skin disease, Japanese encephalitis

H-index
Combined ACERA and CEBRA: 95

3. Collaboration (non-core stakeholder engagement)

Undertake strategic and sustained cross-industry and cross-sectoral collaboration that addresses shared challenges and draws on experience from other sectors.

Outcomes

Non-core projects	
11 Complete	22 Underway

Non-core project budget $8,055,000

☑ non-core research projects cover a range of sectors

Stakeholders

Australian Centre for International Agricultural Research
Agriculture Victoria
Australian Research Council Discovery
Australian Research Data Commons
Australian Pork
Avocado Health
Biosecurity Tasmania
City of Melbourne
Department of Agriculture and Fisheries, Queensland
Department of Agriculture, Fisheries and Forestry, Australia
Department of Environment, Land, Water and Planning, Victoria
Department of Jobs, Precincts and Region, Victoria
Department of Primary Industries Biosecurity and Food Safety, New South Wales
European Food Safety Authority
European Monitoring Centre for Drugs and Drug Addiction
Food Standards Australia New Zealand
Grains Research and Development Corporation
Ministry for Primary Industries, New Zealand
Scion, New Zealand
United States Department of Agriculture
Victorian Marine and Coastal Council
Zespri International Limited

4. Excellence

CEBRA is recognised as excellent within the context of its remit (domestically and internationally), engages a range of disciplinary skills relevant to contemporary risk analysis to ensure governments remain at the forefront of biosecurity risk analysis, and assists in developing Australia's biosecurity risk analysis research capability, including its collaboration with and connectedness to capabilities overseas.

Outcomes

Publications
33 academic papers published in 2022–23

H-index
CEBRA: 51
ACERA: 73
Combined: 95

5 PhD students

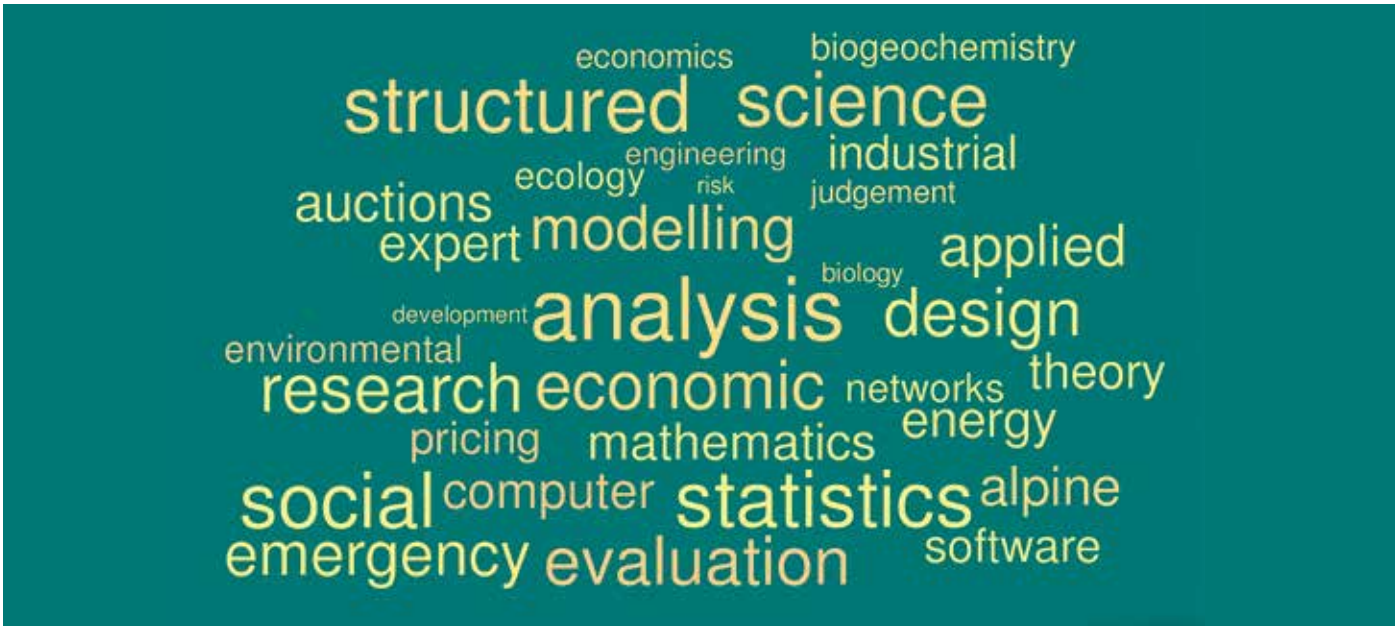
Biosecurity: Managing Invasive Species (NRMT90002) course enrolled student numbers

2022: 54 students

2023: 39 students (to date)

Collaborators: Australian National University; Monash University; Centre for Market Design, University of Melbourne; Biofouling Solutions, Marine Biosecurity Consultants

Core skills



5. Governance

Governance arrangements and practices to fulfill legislative requirements and align with contemporary Australian best practice for open, transparent, and proper use and management of funds.

Outcomes

4 Board meetings	19 DAFF secretariat briefings
4 finance reports adopted at Board meetings	5 governance items endorsed by Board

100% milestones approved

Financial audit complete

Adhered to all UoM policies

6. Monitoring and evaluation

Demonstrate positive outcomes and delivery of research, development and extension activities benefits to core stakeholders and the Australian community in general, and continuous improvement in governance and administrative efficiency.

Outcomes

1 newsletter	8 CEBRAnars (CEBRA webinars)
60+ presentations, workshops and media engagements	
4 communiques	3 progress reports
2 yearly stakeholder survey commencing Sept 2023	
Annual Report Complete	

Financials

Financials

CEBRA is primarily funded by DAFF, MPI and our host, the University of Melbourne.

During the period 2022–23, our total income was $2,444,500, while expenditures totalled $2,255,926.51.

CEBRA 2022-23 Expenditure by Category

Financial Year 2022-23: Breakdown of expenditures

- Research projects – **$1,513,790**
- Operations - **$105,197**
- Business Development - **$97,658**
- Centre Management - **$287,251**
- Program Administration - **$252,031**

DENCH McCLEAN CARLSON

CORPORATE ADVISORY

18 August 2023

INDEPENDENT AUDIT REPORT

TO COMMONWEALTH OF AUSTRALIA – DEPARTMENT OF AGRICULTURE, WATER AND THE ENVIRONMENT (DAWE) 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 Excellences for Biosecurity Risk Analysis (CEBRA) the period 1 July 2022 to 30 June 2023.

AUDIT OBJECTIVE

The objective of the audit was to provide an auditor's report in accordance with clause 6.12 of the Funding Deed dated 25 June 2021. 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 systems 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 $2,255,926.51 expenditure on the Project; and
- the contributions of the University are $562,500.00 in cash and $2,205,460.58 in-kind in accordance with the terms of the Agreement; and
- the project Balance as at 30 June 2023 is $319,913.06

The Financial Statement and Summary of In-kind Support Statement signed by the Director of the Centre of Excellence for Biosecurity Risk Analysis (CEBRA), in accordance with the Agreement are attached.

Craig Geddes
Partner
Dench McClean Carlson Pty Ltd

Dench McClean Carlson Pty Ltd ACN 050 237 315 / ABN 42 050 237 315
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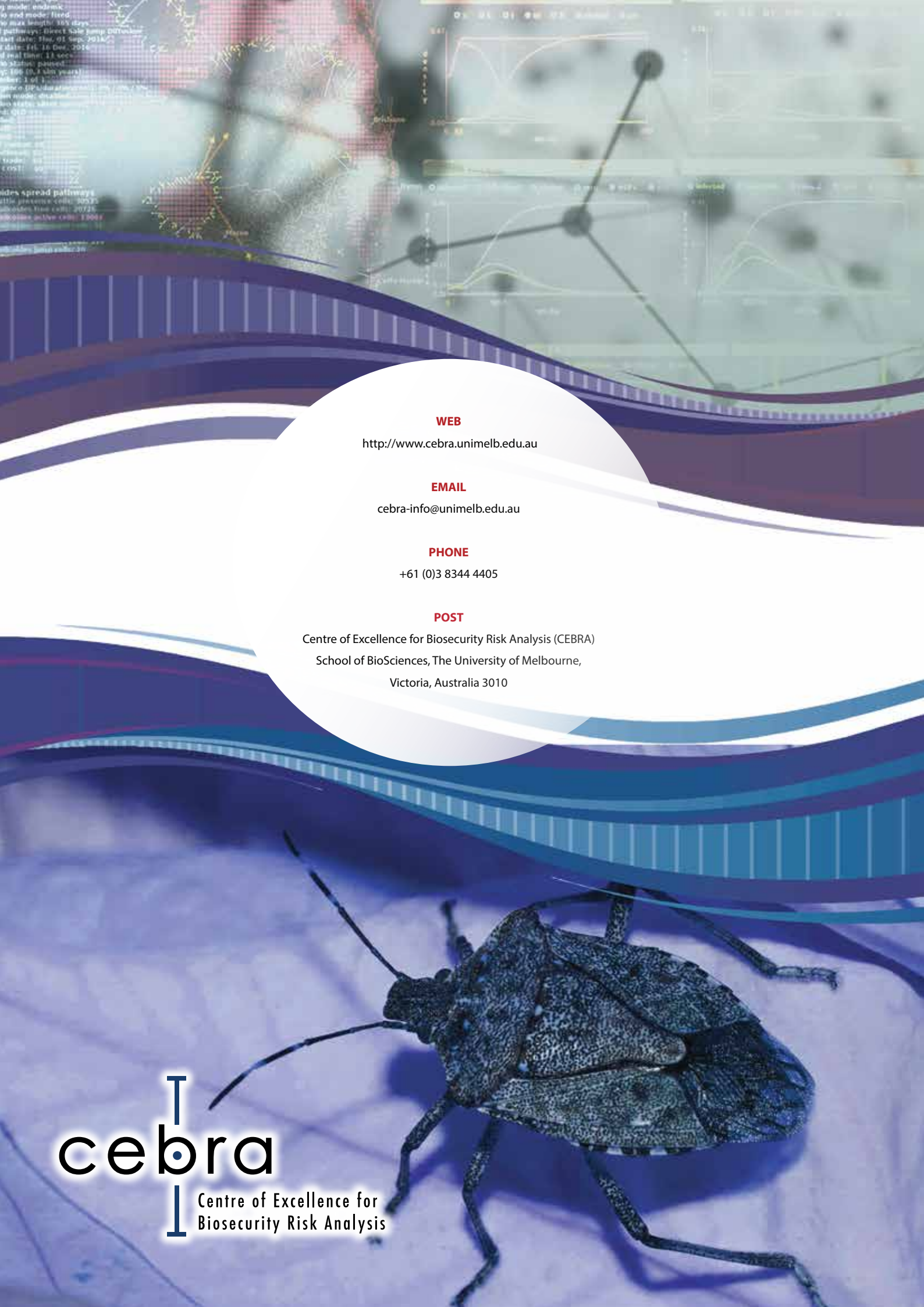

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