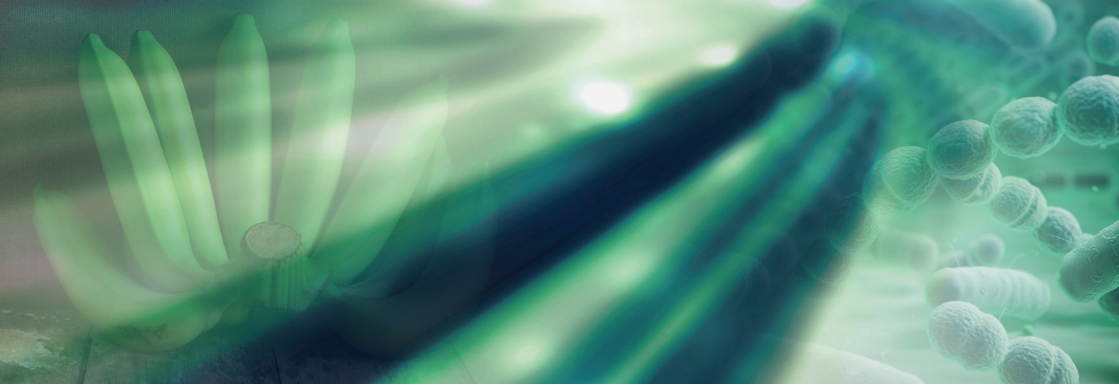
cebra

Centre of Excellence for
Biosecurity Risk Analysis

Who we are | What we do



Australia and New Zealand are relatively free of the pests and diseases that adversely affect other countries. This protects our natural environments and human health; increases the profitability of our primary industries; and enhances our international reputations as trustworthy sources of clean, disease-free produce. Our biosecurity systems protect this freedom. They aim to minimise the risk of entry, establishment and spread of exotic pests and diseases that have the potential to cause harm to people, animals and plants.

Biosecurity is a challenge that evolves with changing risk patterns. Australia and New Zealand have the advantage of being island nations; however, expanding international trade and travel are increasing the risk that invasive species will arrive at our doorstep. Similarly, changing environmental and climatic conditions and patterns of movements of goods, people and animals influence the post-border spread and establishment of invasive species. With limited budgets, Australia and New Zealand's biosecurity systems must respond to these shifting risks using an evidence-based approach while minimising impact on trade and tourism.

What is CEBRA?

Based at the University of Melbourne, CEBRA is a research centre jointly supported by the university and biosecurity regulators the Department of Agriculture, Water and the Environment and the New Zealand Ministry for Primary Industries. 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.

Risk–return

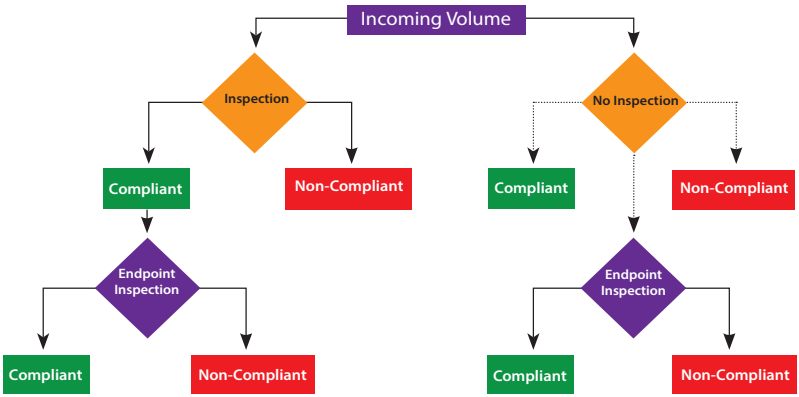
Border inspections of international cargo, mail and passengers aim to reduce the likelihood of biosecurity risk material entering Australia. Historically, regulators prescribed a particular level of activity to achieve this. However, a risk-based approach to biosecurity regulation is more efficient, optimising distribution of limited resources based on statistical information and scientific assessment, and thereby minimising biosecurity risk.

CEBRA has produced a range of tools that assist the department in shifting to a risk-based approach and making informed decisions about resource allocation and efficient intervention strategies.

Evaluating inspection performance

Leakage is the amount of biosecurity risk material that is not detected by routine first-port inspections. It is identified through endpoint surveys and is an important quantity for performance evaluation.

CEBRA developed key performance indicators for border inspections of mail and passengers, which the department has adopted and provides in its annual reports.



14 projects

3 research publications

Risk–return **case studies**

The Department of Agriculture, Water and the Environment has adopted and implemented a range of CEBRA tools and introduced risk-based surveillance to inspection activities at first ports of entry.

Aircans

Aircans are containers for airplane baggage. CEBRA designed a monitoring system and regime for aircans that is based on applied statistics and the operational experience of stakeholders, and also considers the varying constraints of regional offices. Under the adopted monitoring system, the Australian Government's burden of intervention is significantly reduced while having assurance that the pathway continues to present a very low risk.

Risk profiling

The goal of inspections of international passengers arriving in Australia is to intercept risk material. Profiling involves using past inspection experience, including leakage information, to divide arriving passengers into groups according to their estimated risk. CEBRA designed a profiling approach that reduces selection bias by using a technique called raking. The department has implemented CEBRA's approach to construct risk profiles for international passengers and also mail.

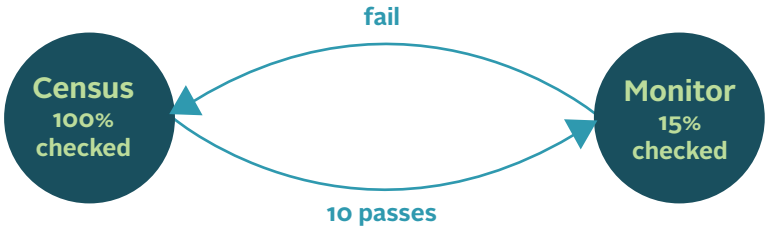
'CEBRA played a vital role in supporting the Department of Agriculture, Water and the Environment implementation of risk-based intervention to more efficiently and effectively manage the biosecurity risks associated with international passengers, mail and cargo.'

Tim Chapman, Department of Agriculture, Water and the Environment

Continuous sampling plans

Checking every single consignment imported into Australia would be expensive and time consuming! This is where continuous sampling plans (CSPs) come in. A CSP rewards consistently compliant importers by reducing the number of compliance checks they must undergo.

There are several kinds of CSPs. Under CSP-1, all consignments are checked, until some clearance number (say, ten) in a row pass biosecurity requirements. At this point, sampling moves into monitoring mode, under which only a percentage (say, 15%) of consignments are checked. However, if a failure is detected, sampling moves back to 100%, until another ten consecutive consignments pass requirements.



CSPs allow targeting of limited resources toward higher risk importers or products. Also, because importers bear the time and monetary costs of biosecurity compliance checks, CSPs encourage importers to choose suppliers wisely and ensure their product is free of biosecurity risk material.

The Department of Agriculture, Water and the Environment uses CSP-3 (slightly more lenient than CSP-1) for certain commodities such as green coffee beans, some nuts and fruit on its compliance-based intervention scheme (CBIS). CEBRA supports the department in expanding the CBIS to other commodities.

www.agriculture.gov.au/import/goods/plant-products/risk-return

11 projects

4 research publications

Continuous sampling plans **case studies**

CBIS in action

CEBRA developed a decision support tool that allows rapid analysis of whether new commodities are suitable for the CBIS.

Further CEBRA research is assisting biosecurity officers to choose the most suitable clearance number and monitoring percentage.

Importer behaviour

Drawing on behavioural economics and microeconomic theory, researchers at CEBRA undertook a series of applied economic experiments to better understand how plant product importers react to incentives under a CBIS.

This has led to a shift in thinking about biosecurity inspection rules and their implementation.

'The work that Plant Import Operations and CEBRA researchers have done together on the CBIS has produced practical, real-world benefits, not only for the department, but directly for importers.'

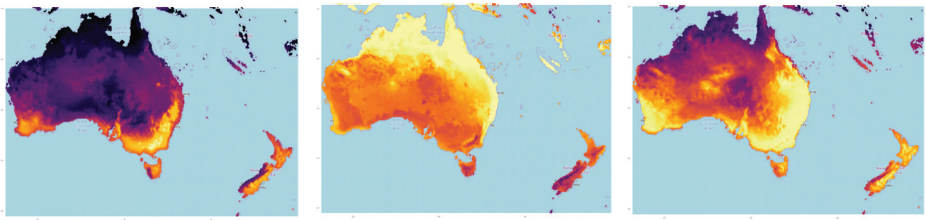
Brendan Woolcott, Department of Agriculture, Water and the Environment

Spatial modelling

Early detection of incursions can reduce the damage caused by invasive pests and diseases. Identifying areas where species are most likely to enter Australia and New Zealand and understanding the way they spread across a landscape helps managers make decisions about how to target resources.

Spatial modelling is useful for predicting the range and spread of potential pests and diseases. Spatial models rely on information about how pests spread and where they can survive. This might include rainfall and temperature records or data on the location of forests, rivers, roads and farms.

Predicting a pest's spread helps risk managers know where to look for the pest, allowing for effective surveillance, control and eradication programs.



CEBRA has applied spatial modelling to a range of pests and diseases:

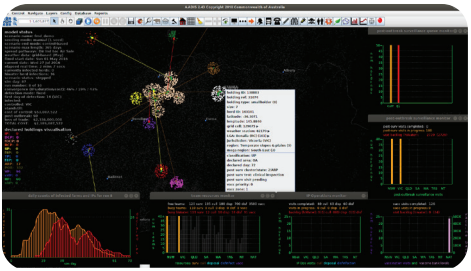
- foot-and-mouth disease
- fruit flies
- Asian gypsy moth
- African swine fever

5 projects

11 research publications

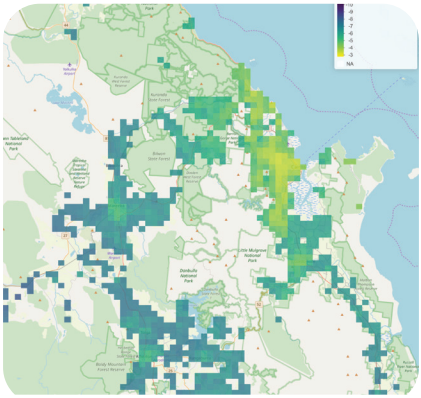
Spatial modelling **case studies**

AADIS



CEBRA developed the Australian animal disease model (AADIS) to model the spread of foot-and-mouth disease. AADIS models this livestock disease across Australia by incorporating spread pathways and current locations of farms. Disease spread is modelled both within and between herds. The tool helps decision-makers to flexibly allocate resources for disease control and model the outcome. AADIS has sparked international interest and has since been adapted for other livestock diseases, vector-borne diseases and plant pests.

Pest risk mapping



Pest risk maps inform surveillance efforts by modelling where invasive species are most likely to establish. CEBRA has developed a novel, transparent and pragmatic framework for creating national maps of pest establishment. These maps incorporate:

- likelihood of pest arrival
- pathways of pest movement within the country
- pest climate suitability
- presence of hosts and vectors.

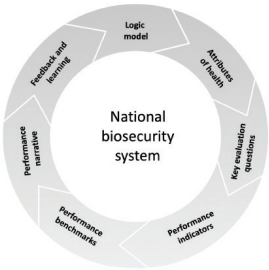
The framework has been applied to create maps for oriental fruit fly *(Bactrocera dorsalis),* Mediterranean fruit fly *(Ceratitis capitata)* and other species.

Health of the biosecurity system

Performance reporting is part of the accountability responsibilities of any government agency. To date, performance evaluation of biosecurity activities has not been done at a national level. To fill this gap, CEBRA has developed a performance evaluation framework that can be repeatedly used to evaluate the health or performance of the national biosecurity system against agreed performance criteria and indicators. When implemented, it will provide an objective basis on which to identify shortcomings of Australia's biosecurity system and to guide evidence-based investment decision-making.

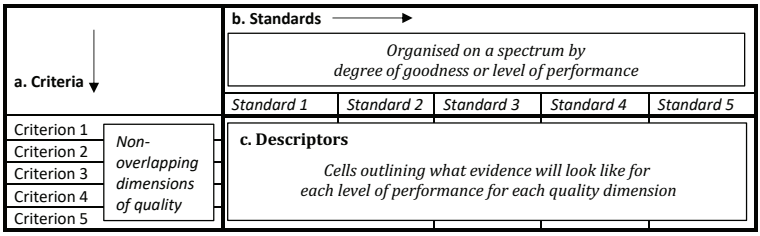
Main project outputs:

- comprehensive description of the national biosecurity system and logic model
- seven step performance evaluation approach
- indicator framework for collecting quantitative and qualitative information.



Use of rubrics

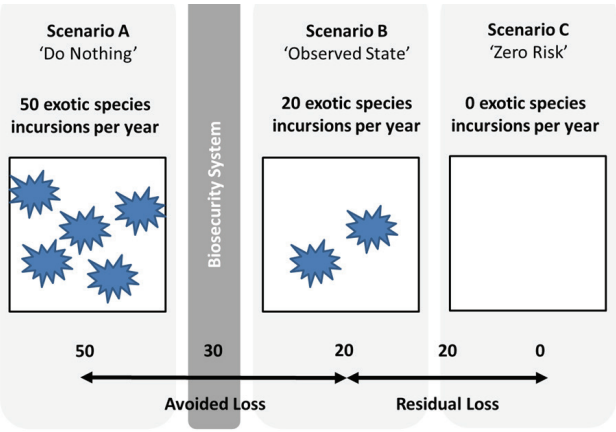
A rubric is a table that presents and captures qualitative information about performance. It requires evaluative criteria and a defined number of performance standards with a description of expected performance. Rubrics are widely used in the education sector, and are increasingly being adopted by program evaluators. CEBRA has integrated rubrics into the indicator framework, to assemble experts' judgements in a robust and transparent way.



Martens, K (2018) Rubrics in program evaluation. Evaluation journal of Australasia 18(1):21–44

Value of the biosecurity system

Australia's biosecurity system provides a substantial benefit by avoiding or minimising the harm caused by invasive pests and diseases. This value is difficult to quantify. This is because the system has a complex interplay of parts across supply chains, geographies, jurisdictions and stakeholders. Past attempts to value the biosecurity system have been based on ad hoc, qualitative statements of overall benefits or limited to specific cases, such as estimating the cost to Australia of an incursion of foot-and-mouth disease.



CEBRA's approach to estimating the value of Australia's biosecurity system involves:

- clearly defining Australia's biosecurity system
- determining the value and geographic distribution of assets protected by the biosecurity system, across Australia
- identifying the key classes of pests and diseases at risk of entering Australia, estimating their capacity for spread, and the associated asset-specific damages
- modelling the arrival, spread, and damages caused by forty classes of pests and diseases across Australia over the next twenty years, both with and without a biosecurity system in place.

Intelligence gathering

Intelligence gathering, in a biosecurity context, is the screening of different sources of information for signals of emerging issues, the fostering of foresight activities to help anticipate future problems, and the analysis of social networks.

One intelligence gathering approach would be to analyse social media output. If there is an increased occurrence of say, the phrase *'weird yellow spots on trees'* in a certain area, this could be an indication of an emerging biosecurity incursion.

Citizen science

Citizen science involves regular citizens or community groups engaging in science-based activities. For example, land care, hiking and environmental groups can act as important detectors of pests, weeds and diseases through what is known as passive surveillance.

CEBRA estimated the value of citizen science and explored the likelihood of biosecurity detections occurring through citizen science.

2 projects

2 research publications

Intelligence gathering **case studies**

Horizon scanning workshops

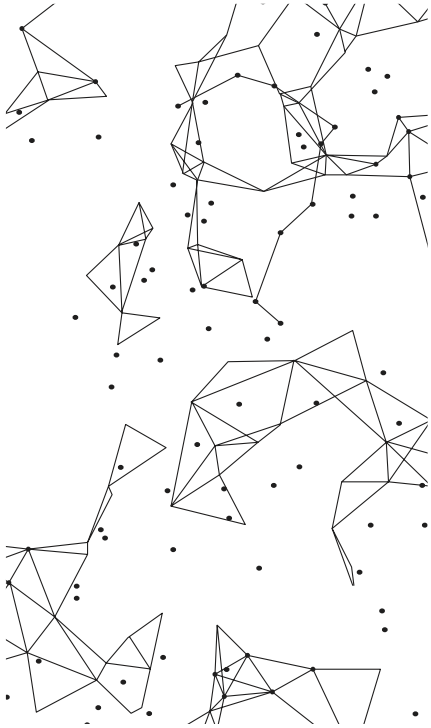
CEBRA sponsored and facilitated a number of workshops that aimed to improve the skills and capabilities of the Department of Agriculture, Water and the Environment to conduct foresight workshops and horizon scanning activities.

IBIS

The international biosecurity intelligence system (IBIS) was developed by CEBRA as an intelligence network for plant and animal (aquatic and terrestrial) biosecurity surveillance.

IBIS has two parts: automated information gathering and a crowdsourcing aspect for data classification and quality control, incorporating a worldwide network of members.

IBIS allows the department to have early warning and better planning and response mechanisms to deal with emerging biosecurity threats, as well as monitoring animal welfare and trade issues.



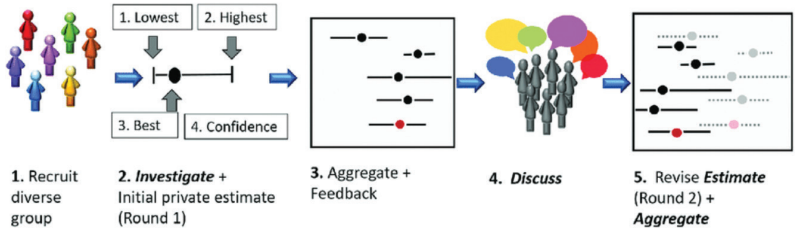
'We wanted to be an international leader in modern biosecurity intelligence, especially for plant and marine aquatic pests and diseases. Working with CEBRA, we believe we have that system (IBIS). Getting the right information to the right people in a timely way is a key part of managing biosecurity for the department and we use IBIS every day.'

Matt Koval, Department of Agriculture, Water and the Environment

Expert elicitation

Obtaining quantitative expert judgements through a structured expert elicitation approach is useful if data are poor or unattainable. CEBRA combined different elicitation strategies, which rely on the phenomenon known as the *wisdom of the crowd*, into a single comprehensive procedure, the IDEA (investigate, discuss, estimate, aggregate) protocol. The IDEA protocol involves asking a diverse group of experts a well-defined, quantifiable question, such as 'How many blue whales are currently in all the oceans of the world?'

Experts provide their lowest, highest and best estimates, together with a measure of confidence that the true value lies between their lowest and highest estimates. Standardised (anonymised) individual and averaged results are then presented to the experts for a discussion moderated by a trained facilitator, after which a revised set of responses is elicited.



Hemming et al (2018) Eliciting improved quantitative judgements using the IDEA protocol: A case study in natural resource management. PLoS ONE 13(6)

CEBRA's researchers have applied expert elicitation in a broad range of biosecurity contexts, including:

- invasive species management
- biofouling risk assessment
- performance assessment
- national security and defence.

6 projects

29 research publications

Expert elicitation **case studies**

Biosecurity practitioners and researchers can use expert elicitation for different purposes such as model parameterisation, conceptual model development and uncertainty quantification.

Vessel hull fouling

Exotic marine species can be introduced on the hulls of ships and boats. CEBRA elicited expert judgements about the likelihood that the arrival of vessels in Australia will result in the establishment of such species. Experts estimated the relative risk of establishment by comparing likelihood incursion scenarios to a reference scenario. The final expert-based model allows relative risk ranking and can support compliance targeting.

If regulators know how much different biosecurity activities contribute towards effective biosecurity management, they can better guide future investment and identify improvement opportunities. Working with the New Zealand Ministry of Primary Industries, CEBRA built a high-level risk-return model using expert elicitation to augment existing data.

Expert elicitation output

The risk return resource allocation model (RRRA model)

The Department of Agriculture, Water and the Environment's RRRA model calculates the number of pests, diseases and weeds that are likely to pass the border each year. The likelihood of them establishing and spreading is combined with the consequences to estimate the biosecurity risk. Assisting model development, CEBRA led a series of workshops eliciting information about pest approach rates, consequences of incursions and the effectiveness of controls.

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