cebra
Centre of Excellence for Biosecurity Risk Analysis

E-UPDATE
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MESSAGE FROM THE DIRECTOR

Welcome to 2019!

We are in the middle of our rigorous project review and approval process. My fellow researchers and I regularly communicate with our colleagues at the Australian Department of Agriculture and Water Resources and the New Zealand Ministry of Primary Industries about the problems they encounter in their important roles as regulators. These conversations drive our project development.

CEBRA—at the crossroads of government business knowledge and academic research—is well placed to tackle these problems. We constantly engage with other researchers and practitioners, sharing skills and knowledge to further the fields of biosecurity and risk analysis. Last November, Dr Steve Lane facilitated an introductory R workshop to the New Zealand Ministry of Primary Industries and New Zealand Customs joint border analytics team, while Professor Tom Kompas gave an invited talk at a national fruit fly committee meeting in Melbourne. In December, Dr Anca Hanea, Dr Rezvan Hatami and Victoria Hemming presented talks at the conference of the Australian Bayesian Network Modelling Society.

The start of 2019 has been busy! Earlier in the year, Dr Aaron Dodd and I were invited to present at the National Biosecurity Committee Research and Innovation Working Group in Brisbane. I spoke on machine learning in biosecurity and Aaron spoke about visions for a digital, data-driven biosecurity system. Earlier in February, Professor Tom Kompas and Dr Terry Walshe facilitated an Introduction to Risk Management training seminar for the NSW Department of Primary Industries in Orange, NSW. Dr Susie Hester presented at a plant biosecurity master class in Salatiga, Indonesia. She received excellent feedback for her efforts and we commend her.

Recently, Tom and Aaron also presented at the 2019 Australasian Agricultural and Resource Economics Society (AARES) in Melbourne. After many years of association with AARES, Tom has been named an AARES distinguished fellow at the conference. Well done, Tom!

In late February, Anca, Victoria and I travelled to Berlin to attend the International Conference on Uncertainty in Risk Analysis, hosted by the European Food Safety Authority and the German Federal Institute for Risk Assessment. Victoria presented a talk on performance weighting and the IDEA protocol for expert elicitation, I presented a poster about using hypotheses tests as decision support tools under uncertainty and Anca facilitated a workshop.

At CEBRA, we appreciate the value of engaging with the wider public about biosecurity. Recently, Tom Kompas led a discussion on ABC's rural country hour about the impact of a foot-and-mouth outbreak. We have welcomed undergraduate interns and school-aged groups through our offices. In this edition of the newsletter we feature CEBRA researcher Dr Jason Whyte, who is bringing his knowledge of mathematics and biosecurity into school classrooms. The problems encountered by the biosecurity systems of Australia, New Zealand (and the world!) are ongoing and evolving; we hope to encourage the next generation of risk analysts to tackle the challenges ahead.

Andrew Robinson

Managing Director,

Centre of Excellence for Biosecurity Risk Analysis

IN THIS EDITION

Dr Jason Whyte: Research Fellow

Jason joined CEBRA in late 2017. He completed his PhD thesis *Global a priori identifiability of models of flow-cell biosensor experiments* in the School of Mathematics and Statistics at The University of Melbourne. The school is a node of the ARC Centre of Excellence for Mathematical and Statistical Frontiers (ACEMS), of which he is an associate investigator.

Prior to moving to Melbourne, Jason had varied duties at The University of Adelaide. These included three years as the technical editor of the Australian and New Zealand Industrial and Applied Mathematics Journal, and facilitating undergraduate workshops in a communication skills course.

Jason's previous research projects have allowed him to gain experience with a variety of mathematical and computational tools. He has modelled rainfall-runoff relationships in the Murray–Darling Basin (Mathematics, Adelaide), the within-host dynamics of malaria (Global and Population Health, Melbourne), and conditions to promote ethical behavior in supply chains (Economics and Business, Melbourne).

Jason is interested in science communication. "Through experiences in undergraduate tutoring (and answering 'What do you do?' at parties) over some years, I observed that most people quickly lose interest in a conversation involving maths," Jason says. As a result, he developed an interest in the communication of mathematical and scientific ideas.

He pursued this by making conference posters with visual appeal. He also assisted the ACEMS team in developing The National Science Quiz, an outreach event that had Adelaide and Melbourne instalments in 2017.

For some years Jason has participated in an ACEMS outreach program: *Doing Maths Like a Research Mathematician*, now called *Mathscraft.* A typical Mathscraft session places groups of secondary school students with a maths teacher, a mathematician and a session leader. The session leader presents a set of problems and students experiment to see what they can discover. The mathematician gives only indirect hints or asks clarifying questions to encourage students to think about problems in different ways. Another strand of Mathscraft is the training of maths teachers to introduce similar open-ended problems into their classrooms. CEBRA supports Jason's continued involvement in Mathscraft. "CEBRA projects have provided concrete examples of what can be achieved with mathematical thinking," says Jason.

These diverse experiences prepared Jason well for his role at CEBRA. Since joining CEBRA, Jason has worked on two of Dr Susie Hester's projects: *1608C Testing incentive-based drivers for importer compliance* and *170602 Increasing confidence in pre-border risk management.*

These projects shared two broad goals. The first was to understand how the importation of particular goods might pose risks to Australia's biosecurity. The second was an exploration of strategies for managing these risks. In each project Jason analysed importation records, requiring interrogation of free text. Jason enjoyed developing code for one task, and repurposing it for others. A highlight of 1608C was the realisation that network diagrams can readily show the change in stakeholder behaviour following a change in the inspection regime applied to incoming consignments.

In 2019 Jason intends to continue to participate in Mathscraft sessions and scientific workshops, learn more Python, finish off manuscripts and produce some attractive data visualisations. Jason says: "I am also looking forward to bingeing on a few arts festivals and my next overseas trip to a destination somewhere near exotic animals. I tend to have some of my best ideas when travelling."

13th Annual Meeting of the International Pest Risk Research Group

When: **3–6 September 2019**

Where: **Poznań, Poland**

The Institute of Plant Protection, in conjunction with the European and Mediterranean Plant Protection Organization are hosting this meeting. More details coming soon: http://www.pestrisk.org/iprrg-2019/

15th Conference on Ecology and Management of Alien Plant invasions

When: **9–13 September 2019**

Where: **Prague, Czech Republic**

The conference will bring together scientists, managers and policy makers from around the world involved in plant invasions, who will interact and explore ways to face global and regional challenges imposed by alien plant invasions. Abstract submission and conference registration open now: https://emapi2019.org/

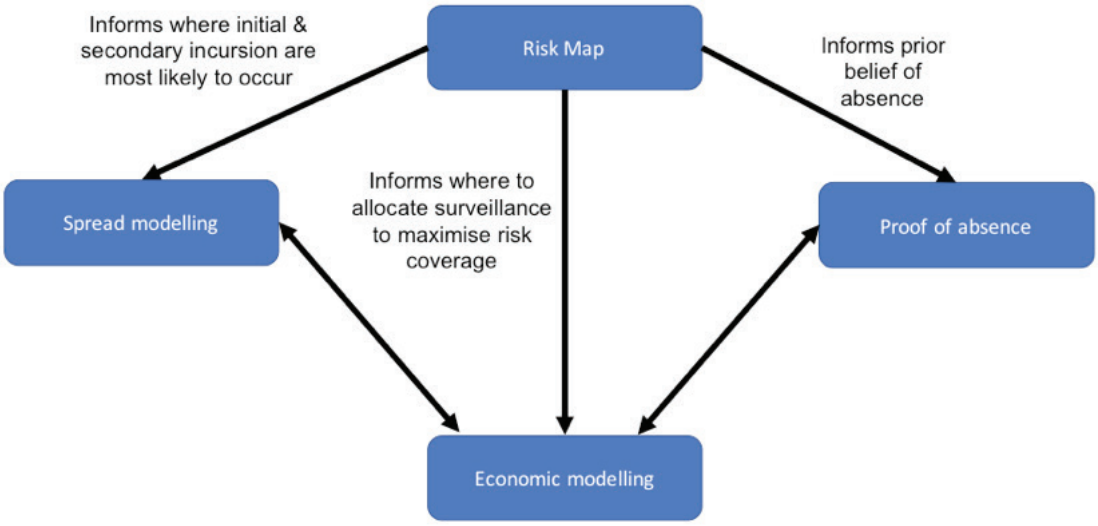
Pest risk mapping to improve post-border surveillance

Dr James Camac

Pest risk maps are a fundamental decision-support tool for biosecurity. They describe where an invasive species may arrive, establish, spread or cause significant economic, environmental and societal harm.

They are commonly used to inform strategic and tactical decisions about how to allocate finite surveillance resources, international and domestic trade restrictions (e.g. phytosanitary measures), and cost sharing between jurisdictions.

They can also inform spread models and can be combined with surveillance data to estimate spatially explicit probabilities of pest absence. Risk maps are also a critical communication tool for raising public awareness, increasing the coverage and effectiveness of passive surveillance.



Examples of how risk maps can be used to inform other post-border biosecurity analytics

Two approaches are commonly used to inform decisions about where to allocate early warning surveillance for pests. The first involves conducting detailed pathway analyses combining interception data, pathway-specific trade volumes (e.g. number of imported containers) and information about the pest's current distribution. The second, more common, approach is to construct models, typically referred to as species distribution models (SDMs) or niche models using physiological data, global occurrence data, or a combination of the two. These models generally use global climatic data (e.g. WorldClim, CliMond) to predict where a pest will survive and successfully establish.

Interestingly, there have been few attempts to integrate pathway analyses with estimates of a pest's environmental suitability. This is despite both pieces of information being critical as to whether a species can successfully establish at a given location. Studies that do attempt to link pathway likelihoods with estimates of environmental suitability are often geographically restricted to points of entry (e.g. ports), and do not make inferences about relative risk of establishment beyond these points of entry. In part, this not surprising, because using statistical approaches to estimate likelihoods of arrival across large geographic areas would require substantial computing power and detailed information about the likely secondary movements of pests once they arrive within a country—data that for a variety of reasons (e.g. privacy, limited resources) is often not recorded, or only recorded for a fraction of the total area of interest.

Here at CEBRA we are developing a novel, transparent and pragmatic framework for creating national maps of pest establishment. These maps integrate:

- A pest/disease's ability to arrive at a given location (i.e. pathways of entry and spread)
- The climate suitability of that location
- The biotic suitability of that location

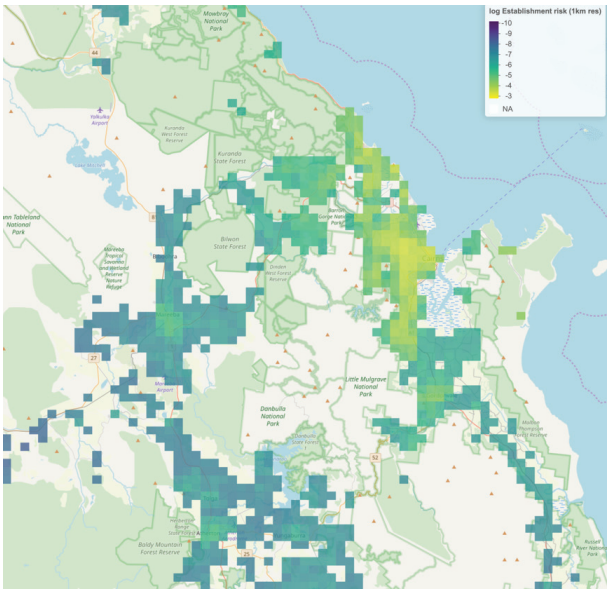
(e.g. presence of hosts/vectors).

We've recently applied this risk mapping framework to address biosecurity problems for two species: oriental fruit fly and Mediterranean fruit fly.

Oriental fruit fly *(Bactrocera dorsalis)* is an exotic fruit fly that is not present in Australia (Camac *et al*. 2018b). We used the risk mapping framework to combine multiple pathways of entry with estimates of biotic and abiotic suitability. We used these maps to determine which areas across Australia were at highest risk of oriental fruit fly establishment and whether the existing targeted trap networks were adequately positioned relative to this estimated risk.

Mediterranean fruit fly *(Ceratitis capitata)* has established populations along coastal regions of Western Australia and has had occasional short-lived incursions in South Australia. In this example (Camac *et al*. 2018b) we used historical incursion data and the risk mapping framework to develop a spatially explicit prior for the presence of Mediterranean fruit fly in a given location. We used this risk map with estimates of trap sensitivity and negative surveillance records from trap networks to derive spatially explicit probabilities of Mediterranean fruit fly absence for central and eastern states.

CEBRA is extending this risk mapping framework to incorporate additional pathways of entry and spread and applying it to other plant pests. We are also developing a practical decision tree to better guide biosecurity practitioners in estimating a pest's climate suitability.



Spatial distribution of B. dorsalis establishment risk across Cairns. Light colours indicate higher estimated risk of establishment.

References:

Camac, J.S., Spring, D., Stanaway, M., Kompas, T. (2018a). National exotic fruit fly surveillance progam. Technical report for the Department of Agriculture and Water Resources.

Camac, J.S., Clarke, S., Niranjane, A., de Majnik, J. (2018b). CEBRA project 1606D: Estimating probabilities of pest absence across geographic space. CEBRA technical report for the Department of Agriculture and Water Resources.

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