2nd Australian Biosecurity Symposium

A decade of biosecurity: turning a moment into a movement

Proceedings

3–5 May 2022 • Gold Coast, Queensland

#BioSym2022

animalhealth AUSTRALIA

20 years invasive species council

CENTRE FOR INVASIVE SPECIES SOLUTIONS

Plant Health AUSTRALIA

Perspectives of Victoria's Biosecurity System - industry, community and government

S Annett[1], **S** Drum[1], K Clift, and M Reid[2].

[1] RM Consulting Group, Victoria

[2] Agriculture Victoria | Department of Jobs, Precincts and Regions

shaynea@rmcg.com.au

The project

Agriculture Victoria is currently delivering the Strengthening Victoria's Biosecurity System (SVBS) Program. A vital component of the SVBS Program is to understand industry, community and government views, knowledge and aspirations for Victoria's Biosecurity System. As part of this process RM Consulting Group was commissioned to conduct a series of interviews with stakeholders in the state's biosecurity system. A total of 114 stakeholders were interviewed covering government, industry, traditional owners and community (Figure 1). The interviews focussed on

- their role in the system and why biosecurity is important to them
- the drivers (incentives, motivations) and benefits of participating in the biosecurity system
- factors that promote or prevent co-operation and trust
- the strengths and weaknesses in the current system

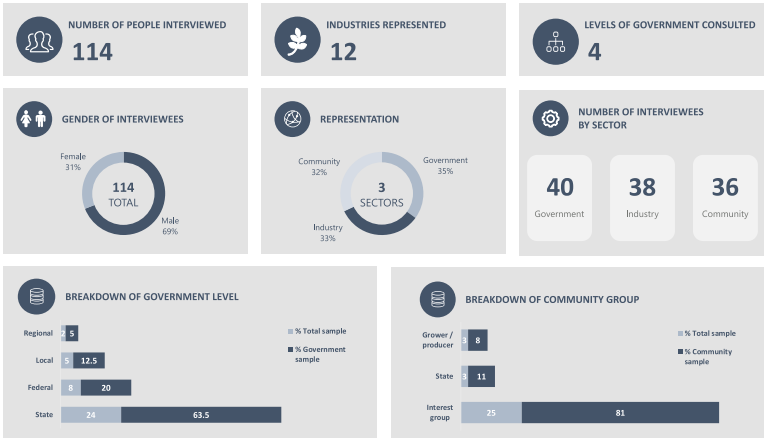

Figure 1 The interview sample

Improving the resilience of the biosecurity system: why should we care?

E Arndt[1], T Kompas[1], A Robinson[1], K Schneider[1]

[1]Centre of Excellence for Biosecurity Risk Analysis, University of Melbourne, VIC, Australia

edith.arndt@unimelb.edu.au

Broadly defined, resilience is the ability of a system, whether it be infrastructure, a community, or an organisation, to absorb disturbance and recover (at varying speeds) from the impacts until the previous level of functionality has been reinstated. Australia periodically experiences incursions and outbreaks of pests and diseases that send a sudden shock to the biosecurity system. These disturbances are often low probability events that have moderate to high impact (e.g., white spot disease or equine influenza outbreak). If the biosecurity system cannot sufficiently withstand these sudden shocks, then the economic, environmental, and societal consequences can be significant. Strategically enhancing the resilience of the biosecurity system can potentially reduce or prevent them, minimising the risk to national biosecurity.

CEBRA recently completed a three-year project on developing a performance evaluation framework for the national biosecurity system. Resilience was investigated as one attribute of system health. Project outcomes included a review of the resilience concept and how resilience characteristics have been identified across domains. A resilient biosecurity system was described as one that is aware, prepared, resourced, responsive and adaptive. These evaluation criteria were integrated into an innovative, qualitative apparatus for resilience evaluation. However, we argue that a quantitative approach should also be pursued because modelling can not only support estimating the status of current system resilience (the status quo), but also be used to predict and evaluate resilience outcomes of competing investment choices, with the aim to facilitate decision making and achieving a net benefit from resilience-enhancing management activities.

Engaging the next generation of biosecurity warriors.

J Bailey[1]

[1]NSW DPI Plant Pathology & Mycology Herbarium

Jordan.Bailey@dpi.nsw.gov.au

To celebrate the International Year of Plant Health in 2020, NSW DPI developed a plant health and biosecurity awareness webpage using our existing Biosecurity Warrior character. The webpage had users exploring a sick tomato plant and learning about all the different ways that pests and diseases can damage plants, and how we can help protect plant health – our biosecurity duty. The page was hosted on the virtual Sydney Science Trail in partnership with the Royal Botanic Gardens and the Australian Museum, for National Science Week.

We are now working to develop this content further into an app that would target upper-primary students. We would work to make this an extension of the Mission Biosecurity website and develop the content with educators to ensure that it fits the curriculum and needs of teachers. BUT it would also be fun, we want to include additional modules and interactive elements such as biosecurity "warrior training", virtual surveillance activities and diagnostics, videos with real world biosecurity staff and scientists, mini-games, and augmented reality.

It is important to keep momentum behind the Biosecurity Warrior character and Mission Biosecurity brand, and message. This project will work to raise awareness and understanding of what biosecurity is and why it is important with a younger audience. It will also work as a platform to showcase the work of biosecurity staff and scientists that protect Australian plants and animals, in industry and the environment and offer children a glimpse at career paths in biosecurity and plant protection.

In the same way that "Healthy Harold" has educated generations of children in healthy eating, creating a digital education environment for biosecurity will lead to social change in the biosecurity space, producing a generation of biosecurity informed citizens.

Join this session or visit the poster to learn more!

What can biosecurity learn from COVID?

C M Baker [1 2 3]

[1] School of Mathematics and Statistics, The University of Melbourne, Australia

[2] The Centre of Excellence for Biosecurity Risk Analysis, The University of Melbourne, Australia

[3] Melbourne Centre for Data Science, The University of Melbourne, Australia

cbaker1@unimelb.edu.au

The COVID-19 pandemic has demanded a coordinated response from every state and territory in Australia. One phrase that almost every leader spoken is 'we will be guided by the health advice', and the Doherty modelling team at The University of Melbourne is one of the groups routinely called on to provide advice. In this talk I will use examples of my work to show how the Doherty modelling team engages with decision-makers (including Chief Health Officers and National Cabinet), showing both successes and failures. These includes work on the National testing strategy; modelling how vaccines and variants shift the risk landscape; support during outbreaks in Fiji, French Polynesia and Papua New Guinea; and input into the World Health Organisation's global vaccine allocation strategy.

Our work highlights the need for independent scientific and modelling to provide advice for managing outbreaks, and similar processes should be in place when dealing with future biosecurity emergencies. There is much to learn from the COVID-19 experience. One key area is planning and preparedness. Without years of work in developing mathematical methods for supporting decision-making in a pandemic, we would not have been able to produce useful results under the timeframes required. Further, without established data streams, such as the National Notifiable Diseases Surveillance System, we would struggle to obtain the required data. But most importantly, we have relied on having trusted relationships, which have allowed us to pinpoint important questions for policy and produce models tailored to those questions. To ensure we are prepared for future outbreaks, we must already have the systems in place that will allow the right people to get the right information at the right time and to therefore act accordingly.

Understanding virus survival to accurately model local farm-to-farm spread of emergency animal diseases

N S Balasubramanian[1], P Jansen van Vuren[1], M Eschbaumer[2], A Schulz[2], P Caley[3], T Bruce[3], W Vosloo[1]

[1]Transboundary Animal Diseases Mitigation, Australian Animal Health Laboratory, CSIRO Health and Biosecurity, Private Bag 24, Geelong, Victoria, 3220, Australia

[2] National Reference Laboratory for FMD, Institute of Diagnostic Virology, Friedrich-Loeffler-Institut, Suedufer 10, 17493 Greifswald-Insel Riems, Germany

[3] Data61, CSIRO Health and BioSecurity, Black Mountain, Acton, ACT 2601, Australia

nagendra.singanallur@csiro.au

A nationwide outbreak of foot-and-mouth disease (FMD) would devastate Australia's agricultural industry and economy resulting in losses in excess of $50 billion dollars. These impacts could be similar with other emergency animal diseases (EADs) posing an imminent threat such as African swine fever, Lumpy skin disease and African horse sickness. Rapid reporting, containment and eradication will expedite industry continuity through quick resumption of trade and exports.

Many natural and artificial routes have been implicated in spread of EADs. In some historical FMD outbreaks, wind dispersion, under very specific climatic conditions, has been implicated in the transboundary spread of FMD virus (FMDV). However, in Australia the conditions are highly variable in different regions and often seen as not conducive to long distance wind dispersion. We are interested in short distance spread where local climatic conditions could be favourable for spread between farms. It is therefore necessary to consider temperature extremes and varying relative humidity levels in modelling virus survival. Current data are not sufficient to ensure accurate modelling of between farm spread and new data are needed to understand the inactivation kinetics of different viruses. Combining this information with other epidemiological factors will assist in modelling disease transmission pathways and designing tailor made control measures.

We used FMDV as a model to map the inactivation kinetics of different serotypes to study the influence of temperature and relative humidity on virus survival over time to use in current dispersal models. We will model the impact of increasing temperature and humidity on virus survival using linear and non-linear regression models and compare within and between strain differences. The design and data from this study will

provide a framework for similar studies on other viruses where wind dispersion is thought to play a role, to obtain scientific data to support dispersion model development.

Gene drives for vertebrate pest control: spatial modelling of eradication probabilities and time-to-eradication for invasive alien mammals in Australia

A Birand [1], P Cassey[1], J V Ross[2], P Thomas[3;4], T A A Prowse[1]

[1]Invasion Science and Wildlife Ecology Lab, School of Biological Sciences, The University of Adelaide, Adelaide, Australia

[2]School of Mathematical Sciences, The University of Adelaide, Adelaide, Australia

[3]School of Medicine and Robinson Research Institute, The University of Adelaide, Adelaide, Australia

[4]South Australian Health and Medical Research Institute, Adelaide, Australia

Invasive alien species continue to threaten global biodiversity. CRISPR-based gene drives, which can theoretically spread through populations despite imparting a fitness cost, could be used to suppress or eradicate pest populations. However, gene drives in mammals are yet to be developed, and proof-of-concept studies have largely been restricted to modelling short-lived organisms. We develop an individual-based, spatially explicit, stochastic model to simulate the ability of CRISPR-based homing and X-chromosome shredding drives to eradicate populations of invasive alien mammals in Australia, using rodents (mice and rats), rabbits, cats, and foxes as target species. Through the model, we explored the interactive effect of the efficiency of the drive constructs and the spatial ecology of the target population on the outcome of a gene-drive release. Our results revealed that both drive strategies could be used to eradicate large populations of these vertabrate pests; however, parameters related to drive efficiency and demography strongly influenced drive performance. We also show that highly efficient drives are not always optimal. When dispersal capabilities are low, rapid local population supression around the introduction sites can cause loss of the gene drive before it can spread. We conclude that, although the design of efficient gene drives is undoubtedly important, accurate data on the spatial ecology of target species is critical for predicting the result of a gene-drive release.

Ensuring Tasmania's biosecurity future- 15 years of the Tasmanian Biosecurity Strategy

A C Bishop[1]

[1] Biosecurity Tasmania, Natural Resources and Environment Tasmania

Andrew.Bishop@nre.tas.gov.au

Tasmania's biosecurity system is central to the island State's Tasmanian brand and its island advantage. This has been recognised for many decades but had never been formalised into a plan for a systems-based approach to biosecurity activities in the State. The drafting of the first strategic plan for the biosecurity system in Tasmania began in the early 2000's and included formal documentation of the State's biosecurity policy principles.

The Government of Tasmania released the first state government biosecurity strategy in 2006 that both described and documented a systems approach to its biosecurity activities. Both the strategy, and associated policy principles, also provided valuable points of engagement for all stakeholders including industries, residents, and visitors to Tasmania.

The strategic approach to Tasmanian biosecurity has been maintained through the release of an updated strategy in 2013 that continues to provide a sound strategic policy base for the Tasmanian Biosecurity System. The plan and policies released in 2013 are still used by Biosecurity Tasmania in establishing and maintaining its work program.

The Tasmanian Biosecurity Strategy has resulted in the structured development of the biosecurity system in Tasmania over the last 15 years. It has embedded the concept of a biosecurity continuum, intelligent risk management, and ensured national and international biosecurity commitments are met. The plan has demonstrated a recognition of the importance of partnerships and that biosecurity outcomes are everyone's business. Clear commitments to emergency response capability have been guided by the requirements identified in both the strategy and policy principles. The last fifteen years has seen advances in comprehensive, and technically sound policy mechanisms as well as contemporary biosecurity legislation identified as necessary in the very first strategic plan in 2006.

The third iteration of the Tasmanian Biosecurity Strategy will continue to be the primary vehicle future proofing Tasmania's biosecurity system.

Machine learning and biosecurity: a pathway to making interventions scalable

N J Bloomfield [1]

[1] Centre of Excellence for Biosecurity Risk Analysis, University of Melbourne, Melbourne, VIC

Nathaniel.bloomfield@unimelb.edu.au

Governments often need to manage the biosecurity risk of high-volume pathways. These present a unique challenge as large pathways with low rates of biosecurity failures (e.g. non-compliance) still present a significant overall risk. As trade and passenger volumes for these pathways increase, spending will also need to grow at an even faster rate to maintain current residual risk levels. Machine learning is a rapidly developing field that can provide the tools biosecurity officers need to manage such pathways and scale interventions, from assisting in the selection of international airline passengers for screening on the basis of risk to automating the detection of plant diseases using aerial imagery to support eradication and containment responses.

Nevertheless, applying machine learning methods to develop real-world solutions can be highly complex. In this presentation we will describe the types of problems these emerging technologies are best suited to solve and the challenges with their development and use. We will draw on our own experience collaborating with the Department of Agriculture, Water and the Environment to develop an automated image recognition method to identify biofouling on vessel hulls as an example.

Biofouling, the accumulation of organisms on surfaces immersed in water, is a concern to regulators as it poses a biosecurity risk by providing a pathway for non-indigenous marine species to establish in new areas. The goal of this project was to provide regulators with the tools to assess in-water inspection footage more consistently and on a much larger scale – allowing regulators to undertake compliance checks and review the evidence provided to them much more cost-effectively. While this pilot study was ultimately successful, we encountered many common challenges faced by machine learning approaches and a roadmap to implementation remains.

Modelling the spread and control of African swine fever in Queensland's domestic and feral pig populations

R Bradhurst[1a], G Garner[1b], S Roche[2], R Iglesias[2], N Kung[3], B Robinson[3], S Willis[3], K Richards[4], B Cowled[5], M Oberin[6], C Tharle[6], S Firestone[6], M Stevenson[6]

[1a] Centre of Excellence for Biosecurity Risk Analysis, University of Melbourne

[1b] Consultant to Centre of Excellence for Biosecurity Risk Analysis, University of Melbourne

[2]Department of Agriculture, Water and the Environment

[3]Biosecurity Queensland, Department of Agriculture and Fisheries

[4]SunPork Group and Australian Pork Limited

[5]Ausvet Pty Ltd

[6]Faculty of Veterinary and Agricultural Sciences, University of Melbourne

Richard.bradhurst@unimelb.edu.au

Introduction

The challenge of planning for emergency animal disease outbreaks can be compounded by the complex epidemiological interplay between livestock, wild animals, and the natural and human-influenced environment. For example, if African swine fever (ASF) were to enter the Australian feral pig population it is unclear whether it would establish and pose an ongoing threat to domestic pigs (per the European experience with wild boar), or whether culling a proportion of the feral pig population would lead to disease fadeout (given the disease's high mortality rate).

Epidemiological models can assist in the formation of animal health policy for emergency animal disease, especially where field studies are not possible or practical. We describe the development of a decision support tool to assist disease managers explore the potential spread and control of ASF in domestic pigs and the risk of transmission between domestic and feral pigs.

Materials and methods

AADIS is a national-scale epidemiological modelling framework used by Animal Health authorities in Australia to support disease planning and preparedness. AADIS simulates the spread of infection in livestock via direct contacts, indirect contacts, saleyard spread, airborne transmission and local spread, taking seasonal and regional heterogeneities

into account. Control measures are simulated according to the Australian veterinary emergency response strategy (AUSVETPLAN) and include response imperfections such as resource constraints, false positive reports of clinical disease, tracing inefficiencies, and non-compliance with movement restrictions.

A new AADIS-ASF model was developed to

- represent pig production systems and simulate the potential spread and control of ASF in the Qld domestic pig population
- represent the Qld feral pig population and simulate the potential spread of ASF within and between feral pig groups, and surveillance and control measures in feral pigs
- simulate the potential spread of ASF between Qld domestic and feral pig populations

Results & Discussion

An agent-based model (ABM) was used to model the Qld domestic pig population with six herd types representing commercial production and pig-keepers. The potential spread of ASF between pig farms was modelled by a direct contact pathway that replays historical animal movements as recorded in Australia's National Livestock Information System (NLIS), and an indirect contact pathway informed by regional, seasonal, and production system influences on the risk of transmission.

A geographic automaton was used to model the Qld feral pig population. The potential spread of ASF between feral pig groups was represented by jump-diffusion spread pathways informed by regional and seasonal influences on contacts and transmission. Of particular interest was the potential role of ASF transmission via infectious carcasses and how this varied by region and season.

A novel aspect of the study was the fusion of the domestic pig ABM and the feral pig geographic automaton. The potential spread of ASF between pig farms and feral pig groups was represented by a bi-directional spatial kernel informed by regional, seasonal, and production system influences on the risk of transmission.

The presentation will include a demonstration of the AADIS-ASF model running selected ASF outbreak scenarios of interest in Qld. A follow-on project will expand the model to include other jurisdictions.

Simplifying environmental DNA field protocols for non-specialist use

D Burrows[1], Cecilia Villacorta-Rath[1]

[1]Centre for Tropical Water and Aquatic Ecosystem Research (TropWATER), James Cook University, Townsville, QLD 4811, Australia

Damien.Burrows@jcu.edu.au

Invasive species represent a threat to Australian biosecurity. In the face of these threats, there is an urgent need to better understand and monitor the distribution of key plant and animal species and to detect in a timely manner, the first arrivals of introduced pest species into new locations. The environmental DNA (eDNA) technique represents a sensitive tool that allows for cost-effective monitoring of native and invasive plant and animal species across large geographical areas. It is commonly used, and especially useful, for species that occur at low abundance, such as invasive species at an invasion front. Increasing evidence shows that eDNA methods have the potential to strengthen Australia's biosecurity system through early detection of invasive species. Many regions in Australia are remote and sparsely populated, making it logistically difficult for scientists to conduct extensive fieldwork, which results in many species being under-monitored. Engaging with non-scientists (community members, Indigenous ranger groups and natural resource management organisations) to use eDNA methods can increase monitoring capability in remote areas by orders of magnitude. Conventional aquatic eDNA sampling involves filtering large volumes of water, using lengthy procedures that can result in higher contamination risk and reluctance from non-scientists to carry out field sampling. It is therefore crucial to develop user-friendly field methods that need minimal equipment or training and allow for successful engagement with the community. User-friendly field protocols can accelerate adoption of the eDNA technology, opening opportunities for early detection of invasive species.

This presentation will outline our work in developing a field collection method that requires no equipment or training and simply involves filling sample containers containing a cheap, non-toxic, non-alcohol-based eDNA preservative. We will present on our experiences and success trialing this approach with a range of non-specialist personnel (especially Indigenous Rangers) sampling waters in remote areas of northern Australia.

Empowering industry to manage Panama TR4

D Campagnolo [1], J Pekin[2]

[1]Panama TR4 Program, Biosecurity Queensland, Moresby, QLD

[2]Australian Banana Growers' Council, Rocklea, QLD

Jael.napper@daf.qld.gov.au

Biosecurity Queensland's Panama TR4 Program (Program) has successfully collaborated with industry to control and contain Panama disease tropical race 4 (Panama TR4, the disease) since its first Queensland detection in 2015. The Program is now in 'transition-mode' as the Queensland Government is preparing to empower growers with full control over how the disease is managed into the future.

Panama TR4 is a non-eradicable soil-borne fungus which blocks the vascular system of a banana plant, eventually killing it. Considered one of the greatest threats to worldwide banana production, this disease has left a trail of destruction across international banana industries.

Since 2015, Biosecurity Queensland has worked closely with the Australian Banana Growers' Council (ABGC) to successfully control and contain Panama TR4 to just five properties, a result unlike any other on the global scale. This has been achieved through significant Queensland Government investment in research and biosecurity activities, leveraged by considerable industry investment and grower-led initiatives. The battle lines are now drawn in defence of the disease and government will officially step down from leadership of Panama TR4 management in June 2023. The Program has entered 'transition-mode' as the banana industry prepares to take the reins through its peak industry body, the ABGC.

This presentation will explore both perspectives of transitioning disease management to industry. Hear why it's important for growers to be empowered in disease management, what the challenges are in administrating such a process, and how the Panama TR4 Program is evolving during the transition.

Myrtle rust eDNA surveillance for early detection in Western Australia

M Campos[1], S Tobe[2]

[1]CSIRO Health and Biosecurity, Floreat WA 6014 [2]Murdoch University Medical, Molecular and Forensic Sciences, Murdoch WA 6150

mariana.campos@csiro.au

Myrtle rust (*Austropuccinia psidii*) was introduced to Australia more than a decade ago, with the first record of this oomycete made in New South Wales in 2010. It quickly spread to Queensland, other regions in New South Wales and Victoria. In 2015 it was also detected in Tasmania and the Northern Territory. To date, no detections have been made in Western Australia. Two independent sets of modelling indicate that WA has large regions with suitable climate for this species.

Our project empowers action in Western Australia through the development of two interlinked outputs: a formal surveillance plan for Western Australia; and an eDNA test for the pathogen. The surveillance plan covers the detection of visible signs of the disease in plants, but importantly, also the spores present in the air. The molecular test used is sensitive to very low levels of DNA (10 copies of the sequence or less), which means that it enables early detection. The test can also be scaled up very easily, allowing diagnostic throughput without bottlenecks were we to have a suspect or actual incursion. Only the pandemic strain of myrtle rust has been detected in Australia, so the test was aimed at testing simultaneously against the pandemic strain or other strains.

Throughout this project we wanted to ensure that the preparedness extended beyond our group. We engaged with other government departments, natural resource management groups and other research groups from the start, aiming at interconnectedness between stakeholders and shared responsibility.

A network for the surveillance of land mammals: Integrating pest species as sentinels for coxiellosis.

A-L Chaber[1], L Hayes[2], R Soares Magalhães[3], A Tolpinrud[4], P Taggart[5], C Caraguel[1]

[1] The University of Adelaide, Adelaide, SA

[2] Charles Sturt University, NSW

[3] The University of Queensland, Qld

[4] The University of Melbourne, Vic

[5] NSW Department of Primary Industries, NSW

anne-lise.chaber@adelaide.edu.au

Since colonisation, many non-native species have been introduced into Australia. With an estimated cost of over AUD$70 billion per year to the Australian economy, pest species, such as cats, goats, foxes, deer, rabbits, and pigs can be carriers and/or reservoirs of pathogens of public health significance. We argue that those animals could be sampled to detect pathogens transmissible to humans and/or shared by wildlife and domestic animals and thus serve as part of a national network for the epidemiological surveillance. To illustrate this concept, we have investigated if European rabbits (*Oryctolagus cuniculus*) could be used as a surveillance species for *coxiella burnetii* in Australia. Rabbits are a widely distributed vertebrate pest and have been reported as a reservoir of *c. burnetii* in Europe. This non-native species is abundant in Australia at the livestock, wildlife and the public interface. As part of the national rabbit control program, tens of thousands of rabbits have been sampled and serum archived over the last decade for research on lagomorphs' biological controls and not on Q-fever. We accessed and screened 2,739 European rabbit against *c. burnetii* antibodies sourced from 45 locations across all Australian States except the Northern Territory. Among the rabbits sampled, *C. burnetii* seroprevalence was clustered within three locations in Queensland, two locations in Victoria and one in New South Wales. Other species that are under control and cull program can be targeted as sentinels. We aim to compare those clusters with known clusters in livestock and humans; potentially guiding animal and human health authorities towards locations where targeted surveillance may be needed. Our data demonstrates that *c. burnetii* surveillance in Australia could benefit from the inclusion of pest species in sample collection; opening a discussion around the establishment of a national network for the epidemiological surveillance of wild land mammals.

Development of molecular fingerprinting for early detection of myrtle rust disease and resistant germplasm

D W Coles[1], J Wong-Bajracharya[2], P Tobias[3], J M Plett[1], M C Moffitt[4]

[1]Hawkesbury Institute for the Environment, Western Sydney University, Richmond, NSW 2753, Australia.

[2]NSW Department of Primary Industries, Elizabeth Macarthur Agricultural Institute, Menangle, NSW, Australia.

[3]School of Life and Environmental Sciences, University of Sydney, Camperdown, NSW 2006, Australia

[4]School of Science, Western Sydney University, Campbelltown, NSW 2560, Australia.

D.Coles@westernsydney.edu.au

Prior to onset of disease symptoms, plant pathogens release a plethora of signals including proteins and metabolites into a plant host that regulate the speed and degree of pathogenesis. Plants, in response, attempt to mount an effective immune response to resist the disease, although genotypic differences between individual plants mean that some are susceptible to disease progression. Myrtle Rust disease caused by the introduced fungal pathogen, *Austropuccinia psidii*, is a major threat to native Australian ecosystems infecting more than 380 plant species in the Myrtaceae including *Eucalyptus* spp. which often dominate Australian ecosystems and are commercially important for timber and oil industries. Early detection of the disease is needed to prevent largescale spread and to enable screening of available plant germplasm to determine if there are resistant genotypes. In this study, we aimed to identify plant and pathogen signals, i.e. molecular 'fingerprints' during the early stage of *Eucalyptus grandis* infection by *A. psidii* to develop novel screening tools to track early disease occurrence and identify disease resistant germplasm. To achieve this, we used next-generation sequencing 48 hours after *A. psidii* inoculation in hypersensitive, resistant and susceptible *E. grandis* seedlings. Expression of *A. psidii* pathogenic signals could be detected in leaves and of these three were highly expressed in the susceptible compared to resistant suggesting an importance for susceptible host colonisation and early detection of infection. Host responses prior to

and during infection also differed depending on resistance profiles. Proteins, small RNAs, and secondary metabolic and phenylpropanoid metabolic pathways known to be involved in disease resistance were differentially expressed.Together, the results highlight that transcriptomics reveal genetic cues that can be used as molecular ‘fingerprints’ to detect early infection and the corresponding host resistance level.

Development of an automated spore trap and analysis platform: opportunities for biosecurity surveillance.

L Collins[1,2], R Kimber[3]

[1] University of Sydney, Sydney, NSW

[2] BioScout PTY LTD

[3] South Australian Research & Development Institute (SARDI)

lewis@bioscout.com.au

The applications of and machine learning (ML) technology is providing exciting opportunities in the automation of traditional spore trapping procedures. So called smart traps that incorporate these technologies have the potential to automate the process of sampling aerobiological particles, generate digital images of captured particles and apply diagnostic analyses that identify unique morphological features of airborne spores. This will allow routine enumeration of collected fungal spores for prolonged periods of time with no human intervention. This presentation describes the challenges and opportunities of smart spore traps with on-board microscopy and image recognition and outlines the development of such a system.

The system comprises three main components: an active impaction air sampler, an automated microscopy analysis stage, and a cloud-based ML classification scheme for spore identification. Each sampling unit autonomously adjusts its airflow intake to account for variation in atmospheric conditions. The device progresses sampled tape to a microscopy stage, which autonomously autofocuses and rasters across the sampled area. This imagery is sent via the 4G phone network to the cloud, which processes images using ML techniques to automatically classify captured spores according to their unique morphological features. Time-integrated results are presented on a web-based dashboard daily, which is sent to end-users, which could include government agencies, agronomists and growers.

Targeted case studies from in-field trials have demonstrated the effectiveness of this technology for the surveillance of several endemic plant pathogens, with more proof of concept studies currently underway. This automated system eliminates the need for manual collection and analysis, significantly reducing the costs associated with traditional spore trapping. Smart trap arrays can be integrated into automated area-

wide disease surveillance networks. These networks have the potential of generating a rich dataset for monitoring airborne plant pathogens and therefore, new opportunities for biosecurity applications at farm, regional and national scale.

International trade of seed: science informing risk

F Constable[1], B Rodoni[1], D Dall[3]

[1] Agriculture Victoria Research, Bundoora, VIC,

[2]Australian Government Department of Agriculture, Water and the Environment, Canberra, ACT
Fiona.constable@agriculture.vic.gov.au

Globalisation and expansion of controlled and uncontrolled trade and movement of botanical seed for agricultural growing, domestic use and exchange of germplasm for breeding can result in the spread of seedborne infectious disease. Consequently, seedborne pests and pathogens are increasingly reported beyond their known distribution, globally. The risk associated with imported seed is highlighted by outbreaks of *Pospiviroid* species in Australian greenhouse grown tomatoes since the 1990's and the detection of cucumber green mottle mosaic virus and melon necrotic spot virus in several Australian cucurbit growing regions since 2014.

In recent years there have been several research activities undertaken by Agriculture Victoria Research and the Department of Agriculture, Water and the Environment, to investigate those risks to inform seed import conditions, seed testing at the border and the need for surveillance strategies for uncontrolled importation of seed. Specifically, the prevalence of viruses and viroids has been analysed in imported Solanaceae and Cucurbitaceae seed, since seed testing commenced at the Australian border, and this has been used to inform seed sample size. In another study, one or more targeted viruses were detected in cucurbit seeds from online mail-order providers. A study to evaluate the risk of transmission of '*Candidatus* Liberibacter solanacearum' by carrot seed showed that the risk was negligible. The results of these studies have helped to inform Australian biosecurity policy, protocols research to reduce the introduction and spread of crop pests in Australia.

Lessons learnt from the Ehrlichia canis outbreak in remote Australian Aboriginal communities

B Cumming[1], B Rankmore[1], M Hayes[1]

[1]AMRRIC (Animal Management in Rural and Remote Indigenous Communities), Darwin, NT

bonny.cumming@amrric.org

Since the first detections of the previously exotic disease, canine ehrlichiosis, in May 2020 in the Kimberley, WA, dogs in remote Aboriginal communities have been disproportionally impacted by this disease. AMRRIC (Animal Management in Rural and Remote Indigenous Communities) is a not-for-profit organisation that uses a One Health approach, coordinating veterinary and education programs in remote Aboriginal and Torres Strait Islander communities nationally. Given our extensive networks with the diverse range of stakeholders involved with companion animal health and management in remote communities, despite being a non-government organisation, AMRRIC have played a pivotal role in the various jurisdictional *Ehrlichia canis* responses.

One part of AMRRIC's response to the ehrlichiosis outbreak has been to utilise our educational expertise to develop educational resources about this disease, suited to the unique language, literacy, and cultural context of remote Aboriginal and Torres Strait Islander communities. These resources have been widely disseminated, including AMRRIC's animation being featured on outbreak.gov.au and various jurisdictional animal health authorities' websites. This poster provides an overview of these resources, their distribution channels, and the features that make them engaging and appropriate for the unique context of remote Aboriginal and Torres Strait Islander communities.

Towards a more accountable biosecurity system

R Delane[1]

[1]Inspector-General of Biosecurity

rob.delane@agriculture.gov.au

Australia has a world-leading biosecurity system, however, significant weaknesses exist at national, state/territory, industry and landholder levels, despite a long history of legislative reforms, insights from major reviews, and learnings from incursion and spread of too many pests and diseases.

Are the 'shared responsibility' settings for Australia's national biosecurity system well-positioned to serve our nation's needs today and into the future? Is there accountable delivery of international preventative biosecurity measures? Are actions at state/territory level in keeping with roles articulated and legislated since federation? Are agriculture sectors taking responsibility for mitigating risks to private agri-businesses and shared responsibility for minimizing sectoral production and market access risks? Are landholders, individually and collectively taking accountable action against pests covered for many decades by clear regulatory obligations?

Drawing on recent experiences as Inspector General of Biosecurity and long experience in post-border biosecurity, this paper explores whether the leadership clearly established for more than two decades as various forms of 'shared responsibility' has come to mean 'genuinely committed and accountable', or something much less valuable.

The paper will discuss whether Australian biosecurity has arrived where its course was charted by past biosecurity leaders, including: the landmark 1996 Nairn et al Review 'Australian quarantine – a shared responsibility'; the foundation principle of "minimize risk to all parties" used in drafting of national animal and plant emergency response deeds; reinforcement in 2008 by the Beale et al Review 'One Biosecurity – A working partnership', and; less formal use for more than two decades of messaging like 'agriculture (biosecurity) protection is everyone's business'.

Current biosecurity decision-makers and future biosecurity leaders will be challenged to consider whether 'shared responsibility' has become an unhelpful shroud over 'individual and collective accountability', and how a renewal of accountability within Australia's biosecurity system might occur.

Future proofing aquatic biosecurity: Consistency is urgently needed for Australia's ALOP for prawns

B K Diggles[1]

[1]DigsFish Services Pty Ltd, Banksia Beach, QLD

ben@digsfish.com

White spot syndrome virus (WSSV) emerged from China in 1992 causing the OIE listed White Spot Disease in crustaceans. WSSV was exotic to Australia until 2016, when a WSD incursion caused total loss of production in prawn farms along the Logan River (SE QLD) for 2 growing seasons, followed by ongoing production losses of 44-65% thereafter. Wild prawns and crabs are also dying of WSD, and crustacean fisheries were severely impacted by restrictions imposed in the Moreton Bay biosecurity zone to try to prevent domestic spread of WSSV into other regions. These biosecurity restrictions for all prawn products leaving the zone (cooking or 50 kGy gamma irradiation) represent the domestic Appropriate Level of Protection (ALOP) for prawns originating from a WSSV positive zone.

Aquaculture has the fastest disease emergence rate of all food production sectors, however the Federal Governments import risk analysis (IRA) process is slow and unresponsive. The original prawn IRA published in 2009 took 14 years to complete, but was operational for only 7 years before it failed. Its review has taken over 4 years, and during this time many new prawn diseases have emerged overseas. Scathing reports by the Inspector General of Biosecurity and the Auditor General demonstrate the current decadal scale IRA process (and its recommended testing programs) cannot cope. Beginning to futureproof the seafood sector against emerging biosecurity threats is as simple as cooking all imported prawn products, as required by Australia's obligations under the SPF Agreement, based on the principle of consistency of ALOP. Such arrangements would not discriminate against Australian businesses, and would futureproof biosecurity against both known and emerging prawn diseases, while reducing costs and simplifying compliance. Without futureproofing, exotic disease incursions will continue at an increasing rate, and future generations of Australians and our aquatic environment will suffer for these shortcomings.

Biosecurity is valuable; right?

AJ Dodd [1], J Baumgartner [1], N Stoeckl [2], T Kompas [1]

[1] Centre of Excellence for Biosecurity Risk Analysis (CEBRA), The University of Melbourne, VIC

[2]College of Business and Economics, The University of Tasmania, TAS

aaron.dodd@unimelb.edu.au

Biosecurity is a risk-based pursuit. Regulators are charged with maximising the benefits of burgeoning trade connectivity whilst simultaneously minimising the risk that harmful pests and diseases are introduced in the process. The prevailing paradigm is that a well-designed set of biosecurity interventions will yield large positive benefits, however, this contention is almost completely untested at the system-scale. Research into the relative effectiveness of risk reduction measures typically evaluate either multiple interventions targeting a single pest or, conversely, a single intervention targeting multiple pests – only a handful of analyses have examined the potential effectiveness of multiple interventions targeting multiple pests simultaneously, as they do in practice. Consequently, it is unclear exactly how much monetary 'value' one could expect to be generated by a comprehensive biosecurity system, such as Australia's. Without a clear understanding of the net benefits obtained from the existing investment in biosecurity activities it is difficult to determine the extent to which the system is achieving its desired objectives (its 'health') and also whether there is scope to increase either the value or health of the system by altering the allocation of resources. In this presentation we will present an update on our progress towards estimating the value generated by Australia's biosecurity system and discuss the challenges faced by the team as part of this complex and ambitious project.

Biosecurity Commons Workshop: an innovative cloud-based modelling and analytics platform

AJ Dodd [1],

[1] Centre of Excellence for Biosecurity Risk Analysis (CEBRA), The University of Melbourne, VIC

aaron.dodd@unimelb.edu.au

Predicting the likely establishment, spread and impact of pests and diseases is an integral part of effective biosecurity preparedness and response. However, the tools used to make these predictions vary enormously in terms of their quality, transparency and interoperability. Data, data sharing, software licencing, IT security policy, IP restrictions, compute capacity and software carpentry skills also limit our ability to make timely and repeatable predictions.

Since 2019, the Queensland Department of Agriculture and Fisheries has partnered with the Centre of Excellence for Biosecurity Risk Analysis (The University of Melbourne), Australian Research Data Commons, Griffith University, CSIRO – Atlas of Living Australia and the Commonwealth Department of Agriculture, Water and the Environment to develop the business case for, and fund, a national decision-support platform, called the Biosecurity Commons.

Biosecurity Commons will comprise a cloud-based 'point and click' platform that brings together the best-available data, tools and computing power required to model and analyse pest and disease incursions, now and in the future, in a secure and permissioned environment. This intelligence will enhance decision making capacity for the public sector, support research innovation and contribute to the digital reform agenda for Australian biosecurity.

This workshop will provide you with an understanding of how this new platform will transform biosecurity management decision making. Participants will learn about the platform, its application to their day-to-day decision making and the proposed tool sets. Opportunities to co-design its future roll out and development may also arise. Agencies are also invited to join the collaboration as it proceeds to the next stage.

Building resilience in NSW aquaculture industries

D Doolan[1], A Baker[1], J Curtis[2], L Jungbluth[2], M Walker[1], C Bos[3]

[1]NSW Department of Primary Industries, Port Stephens Fisheries Institute, Taylors Beach NSW

[2]Monash University BehaviourWorks, Monash Sustainable Development Institute, Clayton VIC

[3]NSW Department of Primary Industries, Head Office, Orange NSW

debra.doolan@dpi.nsw.gov.au

There is an increasing recognition within government and industry groups of the importance of biosecurity preparedness and resilience in primary industries, and aquaculture industries are no exception. Recent disease events such as White Spot in prawn farms in south-east Queensland have highlighted the increasing threat this industry faces due to an increasingly connected world, and the need for biosecurity planning across the industry. However, preparedness and planning are variable across the industry and insufficient planning can mean businesses are unable to recover from a biosecurity event. NSW Department of Primary Industries (DPI) is looking to build biosecurity awareness in the NSW aquaculture industry, but how does industry feel about the idea of biosecurity being a shared responsibility and what actions are they already undertaking to protect themselves?

To understand the attitude and awareness of biosecurity issues across the NSW aquaculture industry, NSW DPI engaged Monash BehaviourWorks to conduct social research that aimed to determine current views of aquaculture permit holders on biosecurity issues, and how government can better support industry to make positive changes. Questions DPI is hoping to gain answers for include; What activities are industry already doing that could be supported? What new and relevant activities could industry do with the support of DPI? Do we need to tailor our engagement activities to different aquaculture types or is consistent industry wide messaging the key? The research findings will be used to develop an engagement program that will aim to boost preparedness and resilience in NSW aquaculture industries, so that businesses can improve preparedness and prevention activities, and get back to business quickly after a biosecurity event.

The results of the social research will be presented, along with planned industry engagement tools that will be used by DPI to work with the NSW aquaculture industry into the future.

eDNA meets remote sensing: novel approaches for weed surveillance

F Encinas-Viso[1]

[1]CSIRO, Centre for Australian National Biodiversity Research, Canberra, ACT

francisco.encinas-viso@csiro.au

Accurate and effective detection and surveillance is crucial for management and control of weeds. However, reliable identification and detection requires substantial taxonomic expertise, and it is labour-intensive. This is particularly true in large, inaccessible or remote areas where traditional surveillance is difficult and costly.

eDNA has emerged as a potentially effective tool for weed and pest detection. The ability to detect traces of DNA across multiple substrates (air, water, soil) or pollinators (e.g. bees) significantly increases our ability to undertake rapid early-warning detection and respond quickly complementing data gathered from traditional surveys. One of the main advantages of the eDNA approach is the ability to survey a large number of targets through passive or automated sampling. However, eDNA techniques only provide point-sample data of species occurrences, lacking information about species abundance.

Remote sensing technologies have also proved to be effective for weed surveillance and are able to survey large areas, for example, using unmanned aerial vehicles (UAV). Remote sensing technology and data are therefore useful to conduct surveillance in large and inaccessible areas and potentially estimate species abundance. However, its limitations include poor data resolution and taxonomic identification.

In this talk, I propose the use of an integrated approach which combines eDNA and remote sensing data. The aim is a complementary approach that will increase our ability to make early detections without sacrificing spatial coverage. This integrated approach that uses computer vision data with molecular data, combined with AI/ML methods to handle the large and complex datasets that it will generate, can help us predict species distribution of target weeds with high accuracy across large areas. I will discuss current projects where we are applying this integrated approach and future directions for broad spectrum surveillance of weeds and pathogens.

Developing a proof of concept using Cas12a and LAMP for in-field detection of Xylella fastidiosa

T Farrall [1], S Abeynayake [2], S Fiorito [1], A Dinsdale [1], M Whattam [1], C Gambley [2], P Campbell [2]

[1] Plant Innovation Centre, Plant Import Operations, Biosecurity Plant Division, Department of Agriculture, Water and the Environment (DAWE)

[2] Microbiology and Entomology, Biosciences, Queensland Department of Agriculture and Fisheries (QDAF)

Tom.Farrall@awe.gov.au

Xylella fastidiosa is Australia's #1 priority plant pest of biosecurity concern. Having been established in Europe, America and Asia, and with at least 563 host species being identified by the EFSA in 2018 (EFSA Journal 2018;16(9):5408), there is a need for a rapid and sensitive field-deployable detection method. This is critical for both ongoing 'proof of absence' surveillance and as a delineation response tool in the event of an incursion. Here we report the development of a rapid CRISPR-Cas-based diagnostic tool that combines isothermal pre-amplification with CRISPR-Cas for early detection of *X.fastidiosa*. Upon binding to the pathogen-specific target DNA sequence, CRISPR RNA (crRNA) and Cas12a protein complex becomes activated and degrades single stranded DNA (ssDNA) reporter emitting fluorescent signal (Gootenberg et al., 2018, He et al., 2020). The detection limit of 1.55 fM was achieved and nine *X.fastidiosa* infected leaf samples comprised of multiple hosts and various subspecies (fastidiosa, multiplex and *sandyi)* were detected using this method. Our results suggest that this method is a highly sensitive and specific diagnostic tool for early detection of the *X.fastidiosa* pathogen in operational conditions. The results also suggest the possibility of multiplexing and further improvement as a practical paper-based lateral-flow assay.

Solving the collaboration conundrum – a meaningful approach to improving industry and government collaboration in biosecurity

C Fletcher[1], L Cuttell[2]

[1]AUSVEG, Melbourne, VIC

[2]NAQS, Cairns, QLD

Callum.fletcher@ausveg.com.au;

We propose to outline the success of an industry and government collaboration delivered by embedding industry biosecurity personnel in a government department through secondment opportunities. We describe how the concept, funded initially by the Plant Surveillance Network Asia Pacific (PSNAP), was undertaken jointly by the Department of Agriculture, Water and the Environment (DAWE) and AUSVEG to immerse an industry biosecurity representative within the Department's Northern Australia Quarantine Strategy (NAQS) plant health surveillance team in Cairns in 2021. We will outline specific engagement and surveillance initiatives that benefited both agencies and delivered new perspectives, skills and improved outcomes for plant biosecurity including:

- Join industry/government led engagement and extension activities targeting key, high risk stakeholders and pathways in the North;
- Urban biosecurity focused surveys and outreach activities for community gardens and other associated high-risk sites;
- Leveraging existing industry surveillance and trapping networks to support government high priority targets and data recording requirements;
- Developing innovative joint R,D&E programs to leverage the strengths of both sectors in a collaborative way.

This 'sustained collaboration' approach can be used by others working in the biosecurity space to improve preparedness and resilience across all sectors and regions. Common factors that help improve the relationship building and trust between industry and government will be outlined. Specific approaches to model joint outreach engagement activities targeting key stakeholders will also be presented. We will conclude that this provides a low-cost, high-return model for future embedding scenarios that will be jointly beneficial for both industry and government achieving a truly 'shared responsibility' approach to responding to Australia's growing biosecurity needs and demands.

Making it easy to 'Garden Responsibly' –

An innovative, industry-led approach to a wicked biosecurity problem

A Freimanis[1], H Cherry[2], M Sellen[3] C Perring[4]

[1]Ecohort Pty Ltd, Glenhaven, NSW;

[2]Department of Planning, Industry and Environment, Parramatta, NSW;

[3] Sustainability, Engagement & Communications Consulting, Stanhope Gardens, NSW

[4] Nursery & Garden Industry NSW & ACT, Kenthurst, NSW.

aimee@ecohort.com

The Greenlife Industry reported significant increases in ornamental garden plant sales during COVID-19 lockdowns in 2020: Consumers purchased over 2 billion plants at a cost of $2.6 billion. Benefits of gardening to health, wellbeing, and ecosystem services are well known, thus when people plant a garden, they feel they are doing something good for themselves and the environment. Sometimes the garden plants they choose can become invasive weeds.

The Plant Sure Scheme is being trialled as an innovative, preventative new approach to the wicked problem of invasive weeds. The Scheme enables and empowers producers and consumers of ornamental garden plants to 'garden responsibly', ultimately reducing invasion pressure by driving sales of ornamental plants with a low risk of invasiveness - and reducing the use of high-risk plants.

The Scheme is underpinned by best practice research, including a novel Ornamental Plant Decision Support Tool to predict the level of invasive risk of garden plants, so that low risk plants can be easily identified by producers and consumers. The Tool operates together with a citizen science platform that facilitates knowledge sharing across sectors (industry, government, community) to enable transparency and accessibility to scientific evidence of risk. The Gardening Responsibly platform will allow generation of new information about ornamental garden plants and cultivars, to improve decision making.

Preliminary testing shows that 83% of people would choose a 'certified gardening responsibly' plant over a similar noncertified product. The voluntary Plant Sure Scheme uses positive engagement to encourage pro-environmental behaviours so that people can feel proud of their gardening choices. Through role modelling positive choices and more easily identifying 'eco-labelled value products', the Scheme harnesses market forces to

influence the 30 000 plant varieties traded in Australia and ultimately, to support Greenlife industry contributions to shared biosecurity outcomes and mainstream biodiversity protection.

Northern Australia Biosecurity Surveillance Network (NABSnet)

S Fruean[1], S Fitzpatrick[2], N Kung[3], P Brightling[4], B Tranter[4]

[1]Australian Department of Agriculture, Water and the Environment, Cairns, QLD

[2]Northern Territory Department of Industry, Tourism and Trade, Darwin, NT

[3]Queensland Department of Agriculture and Fisheries, Brisbane, QLD

[4]Harris Park Group, Melbourne, VIC

[5]Tableland Veterinary Service, Malanda, QLD

skye.fruean@agriculture.gov.au

Through *Agricultural Competitiveness* White Paper funding, The Northern Australia Biosecurity Surveillance Network (NABSnet) was established in February 2018, in recognition that private veterinarians servicing the northern Australian extensive pastoral industry could play a greater role in biosecurity surveillance, but face unique challenges that could possibly be lessened through additional funding.

NABSnet utilises the coverage, expertise and good will of these private vets to improve general surveillance for animal pests and diseases of biosecurity concern. The program provides financial support to help cover the costs of conducting a significant disease investigation; access to a variety of practical training and supporting resources to improve vets' capability to conduct quality disease investigations; and importantly, a networking function, helping develop relationships between private vets working in northern Australia, as well as relationships with those working in the government biosecurity sector (particularly vets and laboratory staff).

Since the network was formed in early 2018, 27 vets from 23 private practices have completed over 100 significant disease investigations — a more than 10-fold increase in significant disease investigations in northern Australia compared to pre-NABSnet times. Of these investigations, over 60% have reached a definitive or presumptive diagnosis and over a third have involved notifiable and emergency animal disease exclusions.

The network's success has seen it receive further funding beyond the initial project phase (currently through to 2022) from the Australian Government Department of Agriculture, Water and the Environment (DAWE). NABSnet is managed collaboratively by the Northern Australia Quarantine Strategy (within DAWE), the Northern Territory Department of Primary Industry, Tourism and Trade, the Queensland Department of Agriculture and Fisheries, the Western Australia Department of Primary Industries and Regional Development, and Animal Health Australia.

This presentation will bring together a panel of NABSnet members who play a variety of roles within the network, to share their experiences.

Connecting the dots using AUSPest*Check*™

D. Gale[1]

[1]Plant Health Australia, Deakin, ACT

dgale@phau.com.au

There are currently over 2.6 million dots from across Australia's agriculture sector in AUSPest*Check*™, each representing a discrete surveillance observation. Connecting these dots allows APC users access to intelligence into the health of the national biosecurity system and allows for information led decision making and analysis which was previously unavailable. By encouraging collaboration and data sharing between government and industry, the number of dots can further increase enabling the opportunity to have visibility of comprehensive and up to date data sources.

The revised National Plant Biosecurity Strategy (draft) lists "Improved intelligence and analytics to support risk identification, resource allocation and response" as an outcome under *Strategic Priority 4: Impact through innovation*. In line with this goal AUSPest*Check*™ has now been endorsed as the national plant health surveillance data aggregation system and is deployed operationally. A multi-year trial is also underway to demonstrate the opportunities for AUSPest*Check*™ to support terrestrial and aquatic animal health surveillance. The capability of AUSPest*Check*™ to integrate livestock, plant, environment, pests, weeds, aquatic and wildlife surveillance data into a single cloud-based platform presents opportunities for efficiencies in the national biosecurity system.

AUSPest*Check*™ offers a snapshot of how the national biosecurity system is performing in relation to surveillance at any given time. Using the integrated Microsoft Power BI reporting capability, data is able to be analysed to assess biosecurity risks for specific pests, locations or sectors. This information assists stakeholders to identify gaps in early detection and area freedom surveillance activities. By connecting the dots using AUSPest*Check*™, greater confidence can be instilled in export partners by showing them the quantity of absence surveillance undertaken on specific crops in relation to an identified pest.

This presentation will provide an overview of AUSPest*Check*™ and outline some opportunities for its use in supporting the national biosecurity system into the future.

Behavioural drivers and barriers to responsible keeping and disposal of ornamental fish

G Garbutt[1], I Boutell[2]

[1]NSW Department of Primary Industries, Port Stephens Fisheries Institute, Taylors Beach NSW

[2]NSW Department of Primary Industries, Park Avenue, Coffs Harbour NSW

gayle.garbutt@dpi.nsw.gov.au

The aquarium fish industry has long been recognised as a major source of alien fish entering Australia. Ornamental fish species account for most of the recent fish introductions to Australian freshwater ecosystems, an issue that has been on the rise since the 1960s. Introduced aquarium fish have had, and are continuing to have, adverse impacts on native species including predation and competition for resources, introduction of aquatic animal diseases, ecosystem modifications and genetic effects. The ornamental aquarium fish trade is widespread with 12-14% of the population in Australia believed to be involved in aquaria at some level, an estimated value of $350 million annually (BRS 2010) and an estimated 16M fish imported annually (with 98% of them being freshwater species) (ABARES 2011). There is also a large and unregulated trade between hobbyists across the country.

The release of unwanted ornamental fish into waterways has been identified as an important pathway for fish introductions into the environment. To develop a better understanding of what drives fish dumping behaviour, NSW Department of Primary Industries (DPI) engaged Faster Horses Consulting Pty Ltd. to conduct qualitative and quantitative social research into ornamental fish keeping.

The project aims to understand the attitudes, barriers and drivers to the keeping and disposal of ornamental fish for hobbyists, fish keepers, the aquarium industry and the community. This research aims to determine the level of understanding of ornamental fish as pests in NSW waterways and their impacts; why fish are released into the environment; and alternative methods of disposal and how government and industry could work together to reduce the risks of fish release.

The outcomes from this social research will be presented, along with the education and engagement program targeting NSW pet fish retailers and fish owners that will be informed by the results.

Collaborations between the Bovine Tuberculosis Eradication Campaign and the Biosecurity Authority in Fiji from 2015 to 2020

A Garcia[1], E Borja[2], R Whittington[1], J-A Toribio[1]

[1]School of Veterinary Science, Farm Animal Health, University of Sydney, Sydney NSW, Australia

[2]Animal Health & Production Division, Ministry of Agriculture of Fiji, Koronivia Research Station Central, Fiji

anabel.garcia@sydney.edu.au

The Bovine Tuberculosis Eradication and Control program (BTEC) has been a priority of the Government of Fiji for over two decades to control the zoonotic disease bovine tuberculosis which has adverse economic impacts on the cattle industry of Fiji. In 2017, the Ministry of Agriculture conjunction with the Biosecurity Authority of Fiji (BAF) and the Ministry of Health (MOH), Fiji industry stakeholders and international experts in bTB, decided to put in place a clear policy and strategy for bTB eradication and rehabilitation to address legislative and stakeholder responsibilities, including the immediate removal of infected cattle from farms, the cattle movement control policy to reduce and prevent infection spread from infected farms, auditing and capacity building programmes, and a data recording system for monitoring, evaluation, and learning. Further investment has been approved to develop the new strategy and cover the new testing policy and strategy, zoning, reactor disposal and compensation, as well as governance and operational management including staffing. This presentation will describe the collaborations between the Biosecurity Authority and BTEC program achievements from 2015 to 2020 and further recommendations to provide guidance in revision of the BTEC strategy based on its latest progress to control the distribution of the disease.

Estimating spillover risk through consideration of transmission processes

M Golchin[1,2], A Hoskins[1], R Hickson[1,2]

[1]CSIRO, Health and Biosecurity, Australia

[2]James Cook University, College of Public Health, Medical, & Veterinary Sciences; Australian Institute of Tropical Health and Medicine; and Centre for Tropical, Environmental and Sustainability Science, Australia

Maryam.Golchin@csiro.au

Introduction

Infectious disease emergence from spillover events is of global concern, and it has the potential to cause significant harm to society, the economy, and human life at the global level, as shown by the ongoing COVID-19 pandemic. More than 70% of the +400 infectious diseases that emerged in the past five decades have a zoonotic origin, including all recent pandemics. Zoonotic disease emergence arises from a complex interplay between human, livestock, and wildlife systems.

Methods

All infectious disease transmission requires contact between an infectious and susceptible individual, regardless of their species. As such, in this study we developed a simple estimate of pathogen spillover risk spatially by combining human populations, animal populations, and estimated pathogen populations. We estimate the pathogen population by identifying potential zoonotic pathogens, based on known historic human infections, and cross-referencing with the spatial distribution of the host animal species. Finally, we compared our spillover risk estimate with existing approaches, including statistical and data-driven methods.

Conclusion

Our approach to estimating spillover risk could form the basis of an early warning system for decision-makers at all levels: from local land managers to international biosecurity. Additionally, by fusing with the best available predictions of scenarios of possible futures for the human populations, animal populations, and pathogen populations, our approach has the potential to be used to forecast spillover risk.

Centring social processes and outcomes in invasive species management

S Graham[1], J Atchison[1] Z Ma[2] , L Miller[1,] T Howard[3] , N Gill[1], T Bach[4]

[1]University of Wollongong

[2]Purdue University

[3]NSW Department of Planning and Environment

[4]Environmental System Solutions

Each year untold numbers of land managers, government staff and volunteers work individually and collectively to manage invasive species. Yet metrics of success often focus on ecological and economic outcomes, with little consideration of the social processes and outcomes that underpin biosecurity. Where social metrics have been developed, they often measure the number of hours spent on surveillance and management activities or the number of participants who attended trainings and working bees. Such narrow metrics fail to account for the diverse social successes that shape invasive species management, such as establishment of social networks, connection to Country, skills development, etc. This presentation provides a critical reflection of dominant framings that guide invasive species management, such as risk minimisation and best practice management, and how they overlook social processes and outcomes. We propose that invasive species management needs to be redesigned to incorporate three principles--diversity and justice, learning and failure, and social relationships--into its design. Emerging insights from other fields of conservation practice indicate that re-envisioning invasive species management in this way can enhance social, environmental and ecological processes and outcomes over the long-term.

Mainstreaming biosecurity. How will we get there?

S Graham[1], R Swain[2], A Freimanis[3]

[1]School of Geography and Sustainable Communities, University of Wollongong

[2]Adventure river guide and Indigenous ambassador, Invasive Species Council

[3]Ecohort and Gardening Responsibly Initiative

It is increasingly recognised that biosecurity will only be effective when there is broad support and uptake from large parts of the general community. This has been recognised by the desire of some organisations, including the hosts of the Australian Biosecurity Symposium to create a 'biosecurity mass movement'. This concept was explored during the Biosecurity 2030 workshop held in 2020.

Mainstreaming biosecurity across the community will be difficult and take time. It will require an understanding of the audiences targeted, with different communication methods applied to these varied audiences.

This panel will explore successful and planned community engagement initiatives in the field of biosecurity. Best practice guidelines will be discussed. Areas covered will include weed management, pest animal control, Indigenous heritage, compliance and the plant nursery industry. The panel welcomes questions and comments from the audience.

The impacts of invasive species on Indigenous Peoples' culture and lifestyles and possible ways of addressing it

C Grant[1]

[1]Traditional Owner Working Group for the Reef 2050 Plan.

This presentation will talk about the impact of invasive species on Indigenous peoples' cultural heritage, lifestyles, food supplies etc. The focus will be on the work that the Traditional Owner of the Great Barrier Reef in developing actions and strategies in the Draft Reef 2050 Traditional Owner Implementation Plan 2021-2025 and how this can feed upwards into the CBD's actions and strategies to collaboratively engage with Indigenous Peoples and Local Communities.

Small-holder, big biosecurity opportunity

M Hernandez-Jover [1], L Hayes [1], I Langstaff [2]

[1]Charles Sturt University

[2] Animal Health Australia

mhernandez-jover@csu.edu.au

Small backyard and hobby farmers are a relatively high biosecurity risk for livestock disease where experience and knowledge of biosecurity is lacking or where complacency prevails. In addition, potential to detect an introduced disease across Australia is highly dependent upon the actions of smallholders simply because small holdings are an increasingly common farm type in many areas.

A recent study on producer-led partnership groups (FMD-Ready Project, CSIRO 2020) highlighted the potential to address biosecurity and animal health risks by strengthening connections between producers and biosecurity officers, and by sharing of knowledge to farmers beyond the group. Improved extension and communication networks offered by producer groups increases producers' active engagement and participation within their livestock industry, leading to better biosecurity capability and a decrease in the risks from disease. Key requirements for the ongoing success of producer groups are a business case for funding and a scope beyond biosecurity and animal health, to include livestock production and farming matters broadly.

We extended this line of investigation in 2020-21 to study smallholder networks. First, we described the distribution of smallholders around Australia and the current level of their participation in farming support groups. We then investigated the value of the groups to their members, and their governance and funding, with the aim of informing options for the design of a national network of small holder groups.

Our findings highlight that there is no national network of support for smallholders, and this limits an ability to address biosecurity risks arising uniquely in small holdings. Whilst there are some organisations providing support groups for smallholders, an opportunity exists for expansion of their geographic coverage, and expansion of their scope to include biosecurity, and for leverage offered by national or state-level coordination.

We identified key indicators of success of smallholder groups and identity opportunities for governance and funding. We suggest that a national smallholder group development

coordinator is needed whose role should include liaising with any state or regional coordinators and industry bodies and maintaining of a repository of farming resources for smallholders. We also recommend the addition of a smallholder category within the Property Identification Code database.

Biosecurity and African Swine Fever preparedness in the pig industry in New South Wales

M Hernandez-Jover [1, 2], L Hayes [1, 2], J Manyweathers [1, 2], V Brookes [1, 2], N Schembri [3]

[1]Charles Sturt University, Wagga Wagga, NSW

[2] Graham Centre for Agricultural Innovation, Charles Sturt University, Wagga Wagga, NSW

[3] NSW Department of Primary Industries, Sydney, NSW

mhernandez-jover@csu.edu.au

For improving emergency animal disease preparedness, understanding barriers to effective landholder biosecurity management and how this management can be enhanced is crucial. For the pig industry in Australia, this is particularly relevant given the increasing risk of African Swine Fever (ASF), due to the country's proximity to regions seriously impacted by this disease, and the heterogeneity of pig ownership and biosecurity engagement. This study aimed to investigate attitudes and behaviours of NSW pig producers around on-farm biosecurity planning, allowing for the identification of gaps in biosecurity implementation and providing a clearer understanding of the best communication strategy for each of the different sectors of the industry. Using a human-centered design, a cross-sectional study using an online survey complemented by semi-structured interviews to triangulate the results, was used to gather information on biosecurity behaviour and attitudes and ASF preparedness among pig owners and producers. A total of 187 pig producers participated in the survey, with 14 participating in the interviews. The study identified different 'personas', with most survey participants identifying as non-commercial producers keeping pigs for home consumption or as pets. Despite biosecurity planning being familiar to most participants (89.2%), only 30.7% reported having a written plan; the main barrier to developing a plan being the perception that good practices were already in place. Engagement with other biosecurity practices, such as isolating incoming animals and visitor related practices, was low to moderate. In relation to ASF, despite most reporting high level of concern, awareness of ASF was little to moderate. Clear differences on biosecurity engagement and drivers of this engagement were observed between the different pig producer 'personas'. Findings from this study provide an insight into current ASF preparedness among the industry and how the pig producer population is segmented. This information is supporting the development of targeted biosecurity extension

campaigns using communication strategies that are relevant and appropriate for each sector of the pig industry.

Supporting biosecurity in the sheep and goat industries in NSW: Understanding barriers to implementing electronic identification

M Hernandez-Jover[1, 2], MB Allworth[1, 2], L Hayes[1, 2], J Manyweathers[1, 2], T Marriott[3], **S Britton** [3]

[1]Charles Sturt University, Wagga Wagga, NSW

[2]Graham Centre for Agricultural Innovation, Charles Sturt University, Wagga Wagga, NSW

[3]NSW Department of Primary Industries, Orange, NSW

trudy.marriott@dpie.nsw.gov.au

Efficient traceability is paramount for supporting Australia's biosecurity system as well as maintaining export markets for our livestock industries. Electronic identification (eID) as used for the cattle National Livestock Identification System (NLIS) has proven to support the system to achieve high performance against the National Livestock Traceability Performance Standards. This performance has been reported to be higher than that achieved with the current NLIS for sheep and goats which is based on visual animal identification. For these industries, NLIS animal identification methods used differ between states in Australia, with Victoria being the only state where eID is used as the current NLIS system, with eID being the only identification method allowed for identifying sheep and goats from January 2022. Despite major advances in sheep and goat traceability systems during the last 10 years, such as the improvement of the mob-based systems and NLIS movement records and the implementation of electronic National Vendor Declarations, eID has not been implemented in New South Wales. In 2020, SAFEMEAT recommended nationally mandating eID of all livestock species be completed no later than 2025, to ensure our systems had similar or better performance than those of our international competitors, thus supporting, maintaining and growing international markets. The Department of Primary Industries is responding to this need by undertaking research into identifying the possible barriers of ID implementation in NSW. This will ensure an industry informed and guided approach to eID implementation if it is mandated in NSW, as per the SAFEMEAT recommendations.

The current study aims to gain an understanding of the barriers and motivations of using eID for NLIS sheep and goats in NSW and to provide recommendations for addressing these barriers including the development of a communications plan to improve stakeholder engagement. To achieve these aims this social research study will use a mixed method approach to gather the required data, through semi-structured interviews with stakeholder and a cross-sectional epidemiological and behavioral study among sheep and

goat producers. The data collection tools will be developed using the COM-B model of behaviour change that looks at the capabilities (C), opportunities (O) and motivations (M) that influence behaviour (B). Results from this study will provide valuable insights into the drivers and barriers in relation to the use of eID in the sheep and goat industries in NSW and differences between different segments within these industries. This information will allow identifying targeted recommendations to inform further communication activities for improving engagement of these industries with the use of eID as the official identification system for these species in NSW.

AnimalPLAN: Australia's National Plan for Terrestrial Agricultural Animal Health

K Hewson [1]

[1] Chair, AnimalPLAN Steering Committee

kylie.hewson@chicken.org.au

AnimalPLAN 2021–2026 (AnimalPLAN) is Australia's first national action plan to strengthen our national agricultural animal health system. AnimalPLAN consolidates themes from over 30 existing strategies, plans and frameworks and outlines 21 priority animal health activities, under 7 objectives, for Australia's terrestrial animal industries. AnimalPLAN will contribute to the biosecurity system transformation outlined in the *Commonwealth Biosecurity 2030* roadmap and the Commonwealth Scientific and Industrial Research Organisation's *Australia's Biosecurity Future* report. It will also contribute to achieving the National Farmers' Federation's vision for Australian agriculture to exceed $100 billion in farm gate output by 2030.

AnimalPLAN complements existing strategies and plans and links them through a single strategic action plan for terrestrial agricultural animal health. There are existing include animal health strategic plans for a single industry, region or jurisdiction and national strategies and plans for individual organisations (for example, Animal Health Australia's Strategic Plan 2020 – 2025), or for specific areas such as biosecurity, surveillance, diagnostics, and antimicrobial stewardship. AnimalPLAN links these initiatives and will pursue the common themes they identify.

Animal Health Australia's Industry Forum has endorsed AnimalPLAN. AnimalPLAN will subsequently be considered by multiple levels of government through to the Agriculture Ministers' Forum. This approach will ensure co-ownership of AnimalPLAN by industry and government organisations.

A Steering Committee, with diverse representation from government, industry and Animal Health Australia, has been established to further prioritise, champion and oversee the implementation of AnimalPLAN activities. This Committee will also identify e funding opportunities and provide updates to Animal Health Australia Members' Forum and the National Biosecurity Committee.

Shared Response-ability for Biosecurity: Beyond Educational and Compliance-Based Approaches

V Higgins[1], Melanie Bryant[1,] Marta Hernández-Jover[2], Russell Warman[1]

[1] University of Tasmania

[2] Charles Sturt University

Educational approaches aimed at raising awareness and equipping individuals with the tools to identify and manage biosecurity risks provide the backbone of current efforts by Australian governments and industry to improve responsibility for biosecurity among rural producers. This is supported by a compliance-based approach for dealing with biosecurity breaches by individuals and companies. However, improving producer responsibility for biosecurity represents an ongoing challenge. In this paper, we draw upon qualitative data from a national research project involving interviews with Federal, state and regional-level biosecurity stakeholders to investigate how engaging producers in biosecurity might be improved. Our findings highlight a range of approaches discussed by participants that have potential to engage producers more effectively in a shared responsibility approach to biosecurity including: using the experience of incursions or outbreaks to motivate; leveraging the benefits of endemic disease planning and practice; aligning incentives to farming priorities, and socialisation of risk associated with disease reporting. We argue that making these approaches workable requires a shift from dominant understandings of responsibility as an individual moral or legal obligation to what we term *relational response-ability*. A relational understanding of responsibility is based on: (a) greater recognition of what producers care about, and using this as the starting point for engaging with biosecurity concerns; and b) framing producer responsibility not in terms of what should be done, but on what can be done in the context of existing constraints and producers' broader socio-ecological environment.

Predicting desirability of alien pet birds based on species traits, attractiveness, and availability

K Hill[1], O C Stringham[1], S Moncayo[1], A Toomes[1], J J Tyler[1], S Delean[1], P Cassey[1]

[1]The University of Adelaide, Adelaide, SA

katherine.hill@adelaide.edu.au

The trade of alien species as pets is an emerging source of new invasive species. Identifying the traits that make a species desirable can assist biosecurity agencies in predicting emerging alien species with a potential risk of becoming invasive. Pet trade is shifting from traditional brick-and-mortar pet shops to online sales, which provides a unique opportunity to research the dynamics of Australian pet trade. We investigated the shift of species traded from physical to online trade of pet birds in Australia, and identified the leading drivers behind the purchase of alien and native species. We examined 31,500 online sales of birds collected from a popular online marketplace in 2019, representing 235 species and compared this to physical market inventories from 2011. We then identified what traits correlate with modern (from online data) species popularity, including attractiveness (colour, size, and ability to sing), ease of care, price, and availability in Australian markets. In online trade, 64% of songbird species and 55% of parrot species were alien species. Generally, consumers have a greater preference for cheaper and easy-care species, which are available in a wide variety of colour mutations – traits common in alien species. The popularity of native Australian parrots is less influenced by rarity compared to international markets – instead, consumers prefer "iconic" and common species, such as rainbow lorikeets (Trichoglossus moluccanus), which may present a biosecurity risk when sold outside of their native regions within Australia.

One Biosecurity: a unified approach to integrate risks to human, animal, plant, and environmental health

P E. Hulme[1,2]

[1]Bio-Protection Research Centre, Lincoln University, Lincoln 7647, Christchurch, New Zealand

[2]Centre of Excellence for Biosecurity Risk Analysis, University of Melbourne VIC 3010 Australia

Philip.hulme@lincoln.ac.nz

In the wake of the SARS-CoV-2 pandemic, the world has woken up to the importance of biosecurity and the need to manage international borders. Yet strong sectorial identities exist within biosecurity that are associated with specific international standards, individual economic interests, specific research communities, and unique stakeholder involvement. Despite considerable research addressing human, animal, plant, and environmental health, the science connections between these sectors remain quite limited. One Biosecurity aims to address these limitations at global, national, and local scales. It is an interdisciplinary approach to biosecurity policy and research that builds on the interconnections between human, animal, plant, and environmental health to effectively prevent and mitigate the impacts of invasive alien species. It provides an integrated perspective to address the many biosecurity risks that transcend the traditional boundaries of health, agriculture, and the environment. Individual invasive alien plant and animal species often have multiple impacts across sectors: as hosts of zoonotic parasites, vectors of pathogens, pests of agriculture or forestry, as well as threats to biodiversity and ecosystem function. It is time these risks were addressed in a systematic way. One Biosecurity is essential to address several major sociological and environmental challenges to biosecurity: climate change, increasing urbanisation, agricultural intensification, human global mobility, as well as public resistance to pesticides and vaccines. Unfortunately, the disjointed international regulatory environment presents a significant challenge to biosecurity interventions at a global scale. Three initiatives essential to deal with the global risks from biological invasions: new risk assessment tools that look beyond national borders toward biosecurity risks of international concern, a stronger regulatory instrument to address biosecurity threats at a worldwide scale, and the establishment of a multilateral biosecurity convention

responsible for biosecurity governance. Together, these initiatives will drive a new science and policy agenda to deliver evidence-based governance of global biosecurity.

Engagement is not enough. To fully engage with stakeholders, integration is key.

G Humphreys[1], D Gowell[1], J Spring[1], W Moller[1]

[1]Wet Tropics Management Authority, Cairns, QLD

gareth.humphreys@wtma.qld.gov.au

Yellow crazy ants (Anoplolepis gracilipes) have impacted around 2200ha of land in Far North Queensland, threatening the adjacent Wet Tropics World Heritage Area. Approximately 30% of the impacted area is in sugarcane. Sugarcane farms represent a high level of complexity for management agencies involving multiple stakeholders at each stage of production. Sugarcane farming operations have a high level of risk of moving ants within and between farms. The unpredictable nature of harvester and other machinery movement presents a challenge in tracking, tracing, and predicting infestations. Farmers face what they perceive as increasing interference and regulation from government resulting in a reduction of trust and reluctance to allow access to properties.

To overcome these issues, it is not enough for invasive species management programs to engage with industry. It is essential that programs integrate with industries and their communities.

Facilitated by a well-respected industry liaison officer, the Wet Tropics Management Authority and MSF Sugar began an education program to give each “side” a full understanding of each other’s issues and practicalities. While we deliver education as part of the yellow crazy ant eradication program, to all sectors of the cane industry, program staff also undertake industry delivered training through inductions and presentations on the sugar production process. Knowledge sharing and the establishment of a collaborative data-sharing agreement has been fundamental in strengthening trust and maintaining open communication channels.

The outcomes have been far reaching. Farm activities now consider the potential risks of moving yellow crazy ants at all stages of production. With increased understanding of the industry and access to data, we have developed innovative tools and products to provide practical solutions to help reduce the risk of spreading yellow crazy ants, improved our ability to track and trace infestations and provide predictive ability that has resulted in the identification of previously undetected infestations.

Polyphagous Shot-Hole Borer in WA – a new and emerging threat at the urban forest-residential interface

K Ireland[1], D. Cousins[1], J. Gilliland[1], R. McCauley[1], M. Visic[1] and S. Broughton[1]

[1]Department of Primary Industries and Regional Development, Perth, WA

kylie.ireland@dpird.wa.gov.au

New pest incursions in urban areas present challenges and opportunities. Urban landscapes are incredibly heterogeneous - environmentally, socially and jurisdictionally – and encompass a wide range of biosecurity stakeholders. The impacts on these stakeholders are diverse, with varying levels of concern, participation, and compliance during pest responses. Where maximised, engagement of this diverse suite of biosecurity stakeholders has the capacity to supercharge our capability and capacity to manage current threats and respond effectively to new ones. These challenges and opportunities are typified in the current response by the Department of Primary Industries and Regional Development (DPIRD) to the Polyphagous Shot-Hole Borer (PSHB) (*Euwallacea fornicatus*) in Western Australia. A tiny beetle new to Australia, PSHB is an agricultural and environmental pest, with a wide range of amenity, native, fruit and nut tree hosts.

PSHB was first detected in the Perth metro area following a public report of an infested backyard tree using the MyPestGuide™ Reporter App in August 2021. A Quarantine Area encompassing most of the Perth metropolitan area was established to support surveillance efforts and restrict the movement of wood and plant material. This Quarantine Area and the response has impacted residents, local governments, green-waste operators and numerous plant and wood-based industries such as nursery and wood carving. This has challenged DPIRD to adapt and respond throughout the response, working closely with local industries, councils, and the community to conduct and maximise surveillance and tracing activities.

This presentation will summarise the DPIRD response to date, explore some of the challenges and opportunities present at the urban forest-residential interface, how these were navigated and how we can maximise these learnings to enact transformational change across environmental, social and jurisdictional boundaries.

Boosting surveillance and diagnostic capacity for Australian plant production industries

S Johnson [1], M Quirk[1]

[1]AUSVEG, Melbourne, VIC

Shakira.johnson@ausveg.com.au

The Rural Research and Development (R&D) for Profit program (RRD4P) boosts funding to the rural research and development corporations (RDCs) for nationally coordinated, strategic research that delivers real outcomes for Australian producers.

Two RRD4P programs are bringing together researchers and industry stakeholders from across Australia's diverse plant industries to explore innovative approaches to plant biosecurity surveillance, early detection, and diagnostics in an effort to improve the productivity of our primary producers.

In 2017, the iMapPESTS: Sentinel Surveillance Systems for Agriculture program (iMapPESTS for short) saw each of Australia's plant Research and Development Corporations (RDCs) join forces to change the way airborne pests and diseases are detected.

Using new and emerging technologies, iMapPESTS are investigating advanced surveillance and diagnostic methods to monitor and report the presence of exotic and endemic pests that threaten major agricultural sectors across Australia, including grains, cotton, sugar, horticulture, wine and forestry industries.

Mobile surveillance units, AKA 'sentinels', have been designed to collect samples of either airborne fungal spores or airborne insects, which are then sent to entomologists and molecular diagnosticians for identification of target pests and diseases, the results of which are shared with industry to support on-farm pest management.

In 2019, a second RRD4P program, Boosting Diagnostic Capacity for Plant Production Industries (Boosting Diagnostics), being led by the Grains Research and Development Corporation, commenced. Boosting Diagnostics seeks to expand on the capacity of diagnostics across Australia, aiming to increase Australia's capacity to detect, contain, and eradicate plant pests and disease outbreaks.

Boosting Diagnostics supports the development of new diagnostic tools, underpinned by strong communication and extension activities to raise awareness of these tools amongst diagnosticians and industry. This will assist in early, rapid, and accurate

detection of pests and diseases on-farm and allow swift and precise responses from industry.

A model for grass-roots biosecurity collaboration in the Derwent Catchment, Tasmania.

J Kelman[2], M Wright[2], A Button[1] and M Kelly[1]

[1]Enviro-Dynamics, Hobart, Tasmania

[2]Derwent Catchment Project, Hamilton, Tasmania

facilitator@derwentcatchment.org

In the Derwent Valley and Central Highlands of Tasmania, Landcare, government and industry are collaborating in a grass-roots biosecurity program to protect the region's natural and productive assets. The catchment-based Landcare group, the Derwent Catchment Project, is working with local agriculture and tourism businesses to develop a shared understanding and expectation of biosecurity practice for the region. The agriculture and tourism sectors in the Derwent Valley and Central Highlands currently enjoy a range of market advantages due to Tasmania's relative pest and disease-free status. There are increasing concerns that unsustainable growth in both tourism and agriculture combined with a changing climate may bring new pests, diseases and weeds that will threaten the local economy and the significant natural values of the region.

The Derwent Catchment Project, a longstanding partnership between the Derwent Valley and Central Highlands Council and the community, has established a regional biosecurity working group. This group is working on the premise that a shared understanding of biosecurity expectations among the larger land managers and local employers is key to change in biosecurity practices that address the risks faced by the region. With funding from the Tasmanian Climate Change Office, the working group has developed a regional biosecurity plan based upon a biosecurity threat assessment that considers the changing distribution of pests, weeds and disease with a change climate. The plan identifies a risk-based approach to prevention and response to new and emerging threats, that builds upon the learnings and experiences across sectors, and across jurisdictions.

This presentation will discuss the threat assessment process, the plan and the collaborative actions that the working group is progressing in partnership with key stakeholders within and across businesses and agencies to protect both private and public assets and values.

The Victorian Rabbit Action Network: Our approach to barriers and incentives

H Kleinert [1], L B Adams [2,3]
[1] Agriculture Victoria, VIC
[2] Victorian Rabbit Action Network, VIC
[3] Lisa Adams & Associates, VIC
heidi.kleinert@agriculture.vic.gov.au

The Victorian Rabbit Action Network (VRAN), has co-designed the *Leadership in Rabbit Control Course* to rebuild rabbit knowledge in Victoria. The course is open to people from communities, agencies and the agricultural industry who have a stake in rabbit management in our landscapes.

Facilitators experienced in best practice rabbit management support participants to become local leaders in community led action on rabbits. These facilitators are from community, government and industry groups.

Four learning networks have self-generated from each of these courses. They offer ongoing peer support and motivation. Small grants have also enabled local, collective community action on rabbits.

VRAN encourages participation diversity (gender, industry, regions, community groups, Traditional Owners, land managers, government agencies and other professionals). The diversity allows exposure to a range of knowledge and perspectives and helps support better coordination of rabbit management programs at different scales (local, regional and state).

VRAN offers it's courses at no charge, and considering the overall flow of costs and benefits. VRAN also subsidises travel, meals and accommodation.

Program evaluations show a positive trend towards gender balance in participation, increased confidence in best-practice rabbit control, improved relationships across different parts of the rabbit management system and changed mindsets about how institutions and community groups can work together.

This presentation highlights the unique ways in which the Victorian Rabbit Action Network approaches the barriers and incentives for local collective action on rabbits. Quantitative and qualitative evidence of the program processes and impacts will be discussed.

Raiders of the Lost Arts: Research archaeology for biosecurity risk

L. Kneebone[1], J. May[2], A. Robinson[3]

[1]University of Melbourne, Melbourne, VIC

[2]Department of Agriculture, Water and the Environment

[3]University of Melbourne, Melbourne, VIC

les.kneebone@unimelb.edu.au

The Department of Agriculture, Water and the Environment and the Centre of Excellence for Biosecurity Risk Analysis (CEBRA) are joining forces to develop a new way to structure the library of biosecurity research.

A huge amount of research work has been done that can inform biosecurity risk management. The global body of work is difficult to access for three reasons:

1) location: it is not always published in catalogued research journals;

2) metadata: there is commonly a mismatch between the language that research providers use to describe their products and the language that research consumers use to frame their questions; and

3) outcomes: it is difficult to tell whether the research has been operationalised, what were the learnings and the impediments, and how were they overcome.

These problems are not solved by standard research engines because there is too much ambiguity in search terms, and keyword/title/abstract searches scale very poorly. The search outcomes rapidly become overwhelming.

This in-progress pilot project will develop a way to structure the library of biosecurity research, comprising a user-centered taxonomy based on *key questions* that are informed and structured by an existing model of the biosecurity system. This framework will help better link research users with producers. An extra benefit of using the program logic biosecurity system model to 'frame' the taxonomy is that we will then also get useful insights into the gaps and overlaps of the existing biosecurity research body. Which questions haven't been answered? Which questions are really the same as other questions? What existing work can be applied elsewhere?

The aim of this presentation is to present the key problem and draft solution.

Optimal surveillance against bio-invasions: the sample average approximation method applied to an agent-based spread model

T Kompas

Trade-offs exist between the point of early detection and the future cost of controlling any invasive species. Finding optimal levels of early detection, with post-border active surveillance, where time, space and randomness are explicitly considered, is computationally challenging. We use a stochastic programming model to find the optimal level of surveillance and predict damages, easing the computational challenge by combining a Sample Average Approximation (SAA) approach and parallel processing techniques.

The model is applied to the case of Asian Papaya Fruit Fly (PFF), a highly destructive pest, in Queensland, Australia. To capture the non-linearity in PFF spread, we use an agent-based model (ABM), which is calibrated to a highly detailed land-use raster map (50m x 50m) and weather-related data, validated against a historical outbreak. The combination of SAA and ABM sets our work apart from the existing literature. Indeed, despite its increasing popularity as a powerful analytical tool, given its granularity and capability to model the system of interest adequately, the complexity of ABM limits its application in optimizing frameworks due to considerable uncertainty about solution quality. In this light, the use of SAA ensures quality in the optimal solution (with a measured optimality gap) while still being able to handle large-scale decision-making problems. With this combination, our application suggests that the optimal (economic) trap grid size for PFF in Queensland is much smaller than the currently implemented level. Although the current policy implies a much lower surveillance cost per year, compared to the $2.08 million under our optimal policy, the expected total cost of an outbreak is $23.92 million, much higher than the cost of the outbreak under optimal policy of $7.74 million.

Delivering a win-win - Incentivising accurate and timely general surveillance reporting

H Kruger[1], J Ticehurst, A Van der Meer Simo

[1]ABARES

There is an increasing expectation that people from all walks of life will play a greater role in monitoring and reporting pests, weeds and diseases. The utility and acceptance of general surveillance data requires significant consideration of the systems in place to support accurate and timely reporting.

The Making General Surveillance Work project studied nine general surveillance programs across the plant, animal, marine and weed sectors using systems thinking. These programs were successful in engaging people from a range of groups, including members of the public, certain interest groups, private vets, port authorities and Indigenous communities.

The project found that a nuanced understanding is needed to know who and how to best engage to incentivise quality biosecurity reporting. A variety of measures can overcome barriers to reporting and can be used to meet notifiers expectations, and gain and maintain their support. Getting the message right and notions of shared responsibility are usually not enough. Ideally, different functions across the biosecurity system (e.g. notifier engagement, design of program rules, species identification/diagnosis and data management) need to support people to contribute to general surveillance. Ongoing participation is greatly enhanced when notifiers see direct benefits from their involvement. The nature of the pest, weed or disease at hand also influences how to best design engagement approaches.

In this presentation we will use the lessons learned from the case studies to illustrate the importance of effective early and on-going engagement, building and maintaining trust, tapping into motivations, overcoming barriers, and fulfilling a duty of care towards notifiers. We will discuss the value of knowledge brokers, targeted engagement, positive reporting experiences, monitoring notifiers' satisfaction with a program and ensuring notifier expectations are addressed throughout the various components of a general surveillance program.

Gene technologies as biocontrol tools for innovative and sustainable biosecurity interventions

N Kumaran[1], MA Rafter[1], GC Hunter[2] and S Raghu[1]

[1]. CSIRO Health and Biosecurity, Ecosciences Precinct, Dutton park, 4102, Queensland

[2]. CSIRO Health and Biosecurity, Black Mountain Science and Innovation Park, Clunies Ross Street, Canberra, 2601, Australian Capital Territory

Innovative gene technologies such as 'gene silencing' and 'gene drive' provide opportunities to develop novel genetics-based biocontrol tools for sustainable management of biosecurity threats. These technologies open a variety of pathways for development of a range of sustainable management options to strengthen the biosecurity systems in Australia. For example, gene silencing can switch-off genes mediating adaptation (e.g. growth, herbicide resistance in weeds), and gene drive can be used to spread modified traits and to engineer wild populations with reduced fitness. In this talk we discuss the current trajectories in development of these technologies in the agricultural and environmental biosecurity contexts and compare their progress with the well-advanced gene drive research in the human biosecurity context (e.g. malarial vector management). In addition, we highlight the technical, regulatory, and social acceptance challenges for the development of gene technologies for use in biosecurity. Genetics-based biocontrol have several commonalities with the classical biocontrol approach that has a social license and has been in practice for a century; we discuss how our learnings from classical biocontrol can help to navigate the challenges associated with gene technology research to accelerate its development. Finally, we discuss the importance of industry engagement and support to collaboratively develop gene technologies for sustainable management of biosecurity threats in the future.

Citizen science: a powerful ally for biosecurity

A. Lane[1], J Trezise[2], H Kruger[3], R Cleland[4]

[1] Australian Citizen Science Association
[2]Invasive Species Council.
[3]Biosecurity and Social Science, ABARES (DAWE)
[4]DAWE

Citizen scientists, a vibrant and growing community of people assisting with the recording and monitoring biodiversity in Australia, has great potential to assist with the needs of Australia's biosecurity system.

Citizen science already plays an important role in biosecurity detections in Australia. For example, community reports of new outbreaks accounts for over 70% of total detections of red fire ant nests in eradication efforts in south-east Queensland. Citizen science projects have also led to incidental detections of non-native species. For example, photos uploaded to Bowerbird alerted scientists to new locations for South African carder bees (*Afranthidium repetitum*), Streamwatch surveys led to the first detections of the European black slug (*Arion ater*) in NSW and photos uploaded to 'Bees in the burb' Facebook group recently led to the first records of the European wool carder bee (*Anthidium manicatum*) in Australia.

Improving the contribution of citizen science to biosecurity needs planning and engagement. With the right incentives and supporting systems there is great potential for community-generated detections of species of biosecurity concern to assist with national biosecurity surveillance efforts.

This panel will look at the potential of citizen science to contribute to the national biosecurity system from different perspectives. It will explore diverse examples of citizen science projects, articulate principles for successful citizen science projects, consider project benefits and downsides and explore the issue of data transparency and integrity. The panel welcomes questions and comments from the audience.

Cost-effective portfolio allocation across quarantine, surveillance and eradication using info-gap theory

Y Liu[1]

[1]Harry Butler Institute, Murdoch University, Perth, WA 6150, Australia

Y.Liu@murdoch.edu.au;

Invasive species can lead to community-level damage to the invaded ecosystem and extinction of native species. Ecological systems, and the species within, are highly complex and variable. Uncertainties need to be considered in bio-economic modelling to assist in decision making and evaluate the robustness of designed policy. In our research, info-gap decision theory (IGDT) is applied to model and manage such uncertainty.

Info-gap decision theory is a non-probabilistic theory to enable robust decision making. Such robust decision making methods are often desirable in ecological systems characterized by Knightian uncertainty, without considering the probability or frequency of policy outcomes. This research provides a novel method for applying IGDT to determine the robust population threshold estimate and the allocation of funds in a biosecurity context, in particular the cost of pre-border prevention versus post-border surveillance and eradication.

We use the risk of incursion of the Asian house gecko, *Hemidactylus frenatus* Duméril and Bibron, 1836 onto Barrow Island as a case study. Our work provides guidance for decision makers to balance the robustness against parameter estimate errors and specific total budget limit. We demonstrate that, allocating budget to both quarantine and surveillance results in a more robust option, irrespective of the risk of incursion. Increasing investment in either quarantine or surveillance increases the annual budget, but also decreases the total budget limit. Budget allocated to quarantine should outweigh that to surveillance. A higher estimated population threshold for post-border surveillance detection could increase robustness against unacceptable total management costs. The method outlined here can be used to assist in robust portfolio allocation of limited budget to manage invasive species in a wider context, and to better tackle uncertainty in protection of biodiversity and native species in a cost-effective manner.

Citrus Watch – Launch of a multi-pronged, multi-stakeholder approach to commodity protection

J C Lye[1], N Hancock[1], J Milne[1], S Heaton [2], R Burgess[3], S Taylor[3].

[1]Citrus Australia Limited

[2]Northern Territory Department of Industry, Tourism and Trade

[3]Plant Health Australia

The Australian citrus industry is a significant horticultural industry with production made up of oranges, mandarins, lemons, limes, grapefruit and tangelos. In 2019/20, the national citrus crop was valued at $942.4 million; this is the highest annual value of production ever achieved by the industry. This figure includes $509 million in exported product, which has increased by 171% since 2012/13.

The Biosecurity Plan for the Citrus Industry (Version 3; 2015) identified numerous exotic High Priority Pests (HPPs) that have the potential to significantly impact on the viability of the Australian citrus industry and associated supply chain. Of these, the most serious threat is Candidatus *Liberibacter asiaticus*, the cause of Huanglongbing, and its psyllid vectors, African citrus psyllid (*Trioza erytreae*) and Asian citrus psyllid (*Diaphorina citri*).

In recognition of emerging biosecurity threats, and building on previous industry investments, the citrus industry has launched a new five-year biosecurity program: Citrus Watch.

Citrus Watch will be a collaborative, national program that will extend its reach from commercial production zones, to high-density – high traffic urban and peri-urban regions, to foster informed, aware and engaged early detectors both within the industry and throughout the general public more broadly. It will link with biosecurity agencies, biosecurity programs in other industries, research and extension programs to expand the program reach and identify areas of collaboration and alignment. Ultimately, the program will aim to ensure that the Australian citrus industry remains free of harmful High Priority Pests (HPPs), retains access to key markets through access to robust surveillance data, and has the surveillance mechanisms and expertise in place to quickly detect, identify, and address citrus HPPs.

This presentation will describe past biosecurity activities in the citrus industry that have provided a launchpad for Citrus Watch and will present a roadmap for the program going forward.

Infectious disease high-throughput sequencing, setting us up for 2030

S Lynch[1], J Batovska[1], P Mee[1], W Wong [2], C Morton [2], G Rawlin[1], Brendan Rodoni[1], Fiona Constable [1]

[1]Agriculture Victoria Research, 5 Road Bundoora.

[2]Department of Agriculture, Water and Resources

Stacey.lynch@agriculture.vic.gov.au

High-throughput sequencing (HTS) or next generation sequencing (NGS) is a platform technology that will enable us to build smarter, stronger national biosecurity systems for the detection and analysis of novel and existing pathogens. The quality of this powerful capability, however, heavily relies on professional capabilities and verified workflows (at the farm, at the bench and for the computational analysis). Curated databases of verified genomic sequences to species and often to genotype level also underpin the use of this platform technology to support our biosecurity and pave the way forward.

This HTS / NGS platform technology is being applied now to understand the microbiological communities within livestock, wildlife and the environment. Through metagenomics and targeted metabarcoding processes, Agriculture Victoria Research has applied HTS / NGS platform technologies to progress animal and public health investigations in Australia. From significant disease investigations in undiagnosed syndromes and unexplained deaths in livestock, horses and eels, to ongoing surveillance programs in mosquitoes and arbovirus to support public health and avian influenza surveillance in wild birds, we have applied HTS / NGS platform technology. The outcomes are that we are seeing previously unexpected pathogens and furthering our understanding of the disease ecology for key biosecurity and public health risks.

This innovative technology is paving the way forward into the future with the ability to detect new pathogens and possible biosecurity risks, and support fine-scale genomic epidemiology. We are also working towards developing long-term professional capabilities and verified workflows (at the farm, at the bench and for the computational analysis) and curated databases of verified genomic sequences to support biosecurity now, and in the future.

Weed Wide Web: Surveillance of Online Trade in Declared Plants

J Maher[1], L Wood[1], S Moncayo[1], O Stringham[1,2], A Toomes[1], P Cassey[1]

[1]Invasion Science & Wildlife Ecology Lab, University of Adelaide, SA 5005, Australia
[2]School of Mathematical Sciences, University of Adelaide, SA 5005, Australia
Jacob.maher@adelaide.edu.au

The trade of plants is a major source of invasive species introductions and establishment. In Australia, a large-scale informal plant trade is facilitated by publicly accessible e-commerce websites. This unregulated trade has enabled a rapidly emerging pathway for the spread of invasive plant species (weeds). The trade of declared weeds is illegal and presents biosecurity professionals with a unique set of problems and significant challenges to address.

Thus far, investigations of the online weed trade are done on an ad hoc basis by biosecurity professionals manually searching websites. In response, we have developed a semi-automated method utilising webscrapers to systematically capture the online plant trade. We match search terms based on scientific, common and trade names with text from online plant advertisements to detect weeds being traded. Visual identification with listing images is used to verify detections. Our aim is to quantify and describe the trade to better understand trade dynamics and participant motivations.

Preliminary results show the online trade of weed species is frequent and widespread, with illegal trade present in all states and territories. To date, we have detected more than 100 different species of declared weeds traded online. Cacti, aquatic plants and horticulturally popular, yet invasive, species are the most traded weeds.

Misidentification of plants and the use of generic (non-scientific) names by traders is common. This behaviour suggests an overall lack of awareness of the species being traded, their legal status, and the potential consequences of trading a declared weed. Culinary, medicinal and other uses for plants are purported by sellers, providing insight into the desire for certain weeds. These insights and the methodology developed for this project will provide biosecurity professionals with the information and tools required to detect illegal sales and therefore prevent future weed incursions.

A landscape genetics approach to feral pig management in Australia: what we need to know before we begin

J Manyweathers[1], L Hayes[1], P Durr[2] M Hernandez-Jover[1]

[1]Charles Sturt University, Wagga Wagga, NSW

[2]Australian Centre for Disease Preparedness, Geelong, Victoria

jmanyweathers@csu.edu.au

Introduction

Feral pigs are a serious problem in Australia, damaging crops and pastures and impacting wildlife. They can also carry animal and plant diseases, with African swine fever being of current concern. To better prepare Australia for disease outbreaks, understanding more about the national feral pig population is important.

A Department of Agriculture, Water and the Environment (DAWE) funded project aims to explore the possibility of identifying sub-populations of feral pigs in Australia, using DNA samples to identify populations where mixing and reproduction occur. This paper reports on the pre-project feasibility study.

Aims

The feasibility study aimed to understand:

- The level of stakeholder support for a landscape genetics approach to feral pig management,
- The feasibility of a recruitment strategy aimed at landholders and hunters, and
- Other challenges/risks of the approach to be considered.

Methods

This study used semi structured interviews with a cross-section of stakeholders including community groups, producers, industry bodies and government agencies, with qualitative data analysed using thematic analysis.

Results

A total of 23 interviews were conducted during March 2021. Themes arising from data analysis included consistency in the level of support of a landscape genetics approach to feral pig management and identified some challenges including the need to use existing

relationships and networks, the flexibility needed with meta data (place and time) collection and perceived benefits for participants.

Conclusions

The study found overwhelming support from interviewees. Success of the landscape approach was predicted with using existing groups and networks for data collection, and ensuring adequate resources being committed to understanding and maintaining stakeholder relationships. The study highlighted interest in and energy around feral pig management. The strong existing networks and stakeholder willingness to engage in the study are strong indicators that the Australian Landscape genetics for feral pig management project would find strong support.

Technological advances in biosecurity

B Marks[1]

[1] Chevron, Australia

bmarks@chevron.com

Biosecurity tools are a key aspect of an effective biosecurity system, however existing surveillance and monitoring programs are often expensive, resource intense, reliant on special expertise, long-term and deliver variable results. Advances in innovation and technology provide opportunity to improve program efficiency, reliability and cost-effectiveness.

Chevron Australia have developed and deployed tools to help monitor and identify non-indigenous species on Barrow Island - a Class A Nature Reserve, the second largest island off the coast of Western Australia and home to the Gorgon Liquified Natural Gas plant (LNG). Tools include:

- EARS devices which record the male Asian house gecko's call and can be adapted to incorporate other species if required
- PAWS and PAWS live capture devices for rodent detection and monitoring using digital track pads
- LAMP assay to identify Asian house gecko scats or tissue samples with an in situ molecular tool
- Gecko identification app enabling the workforce to participate in Citizen Science programs

These technological advances have helped to improve surveillance and biosecurity programs on Barrow Island realising benefits including:

- longer monitoring periods for lower costs, resulting in greater confidence in surveillance outcomes
- in-situ diagnostics providing more rapid identification to enact an immediate response
- deploy of live capture devices, reducing non target captures (subsequently a more ethical tool)
- wider workforce participation

Whilst these innovative tools target species likely to threaten Barrow Island's unique biodiversity, the technology can be adapted to species likely to threaten Australia's biosecurity.

Institutional design principles can inform shared responsibility for biosecurity transformation in Australia

Y Maru[1*], H Kruger[2], B Loechel[3], M Hernandez-Jover[4], J Manyweathers[4], M Elhassan[5], J Kelly[1], L Hayes[4]

[1]Commonwealth Scientific and Industrial Research Organisation, Canberra ACT 2601 Australia

[2]Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra ACT 2601, Australia

[3]Commonwealth Scientific and Industrial Research Organisation, Brisbane QLD 4001, Australia

[4]School of Agriculture, Environmental and Veterinary Sciences and Graham Centre for Agricultural Innovation, Charles Sturt University, Wagga Wagga, NSW 2678, Australia

[5] Department of Agriculture, Water and the Environment, Canberra ACT 2601, Australia

Yiheyis.maru@csiro.au

Australia has a strong biosecurity system, but studies indicate that it needs transformational change if it is to build and maintain its resilience. This is key to effectively dealing with increasing and complex biosecurity challenges across the interconnected and interdependent agricultural, marine, human, and environmental health sectors. There are several external and internal drivers increasing risks associated with biosecurity incidents, including the growing volume of trade and travel antimicrobial resistance, population growth, urbanisation, climate change, biodiversity loss, and bioterrorism. Coordinated collective action by different biosecurity actors and across biosecurity sectors is central to transforming and building a resilient biosecurity system. While there are initiatives such as shared responsibility and approaches for integration, such as One Health, that may assist with establishing arrangements for strong collective action, efforts so far have not been well informed by institutional and social sciences. From an institutional design perspective, the public good features of biosecurity present a collective action problem. A collective action problem arises because the benefits from biosecurity measures taken by farmers, a community, a region, and even a nation extend to other non-contributing biosecurity stakeholders, and there is no cost-effective way of excluding these stakeholders from the benefits. This could generate an incentive to free-ride (benefit from other actor efforts without

contributing) which, if done by many actors, would weaken the biosecurity system and increase its vulnerability to incursions. Institutional design principles have been developed through extensive research to address similar collective action problems in other domains. There are also social science systems approaches that assist with developing partnerships and trust among stakeholders. Drawing on 12 institutional design principles from the literature and insights from the Foot and Mouth Disease Ready subproject[1] 'Farmer-led partnership for improved surveillance', we highlight how these insights could assist with framing and addressing biosecurity as a collective action problem, and provide a social science underpinning for shared responsibility.

Linked vulnerability-resilience framework for building resilient biosecurity systems in Australia

Y T Maru[1]

[1]Commonwealth Scientific and Industrial Research Organisation

Yiheyis.maru@csiro.au

Building resilient biosecurity systems is essential given international and domestic drivers such as increasing volumes of trade and travel, climate change, and antimicrobial resistance, which are increasing Australia's vulnerability across the One Health spectrum

Incremental improvements will not maintain Australia's strong biosecurity status into the future. Transformational change is needed to build and maintain resilient biosecurity systems. The themes of this symposium are calling for contributions to understanding the vulnerabilities of the biosecurity system, what enhances the system's resilience, and what is needed for transformational change. There is no clear articulation of these concepts in the biosecurity domain, risking the concepts becoming buzzwords with little value for biosecurity research, policy, and practice. Articulation and adaption of these concepts to the specific features of biosecurity are needed, drawing from the application of sciences of vulnerability and resilience in domains such as climate change adaptation and disaster reduction. Vulnerability refers to the susceptibility of a system (e.g. farm, region, or country) to threats, for example, transboundary animal diseases (TBD), and is determined by the level of exposure to the threats, sensitivity to the threats, and adaptive capacity. Exposure refers to the degree, duration, and extent to which the system is subject to threats. Sensitivity is the degree to which the system is modified or affected by threats. Adaptive capacity refers to the system's ability to respond to threats and moderate potential damage. While exposure and sensitivity are directly applicable to the biosecurity domain, the concept of adaptive capacity requires modification. Response capacity of the systems to threats seems a better fit in the biosecurity domain.

In the social-ecological systems literature, resilience is defined as the capacity of a system to absorb disturbance, reorganize, and still maintain the same controls and key structure and functions. While absorptive or coping capacity to maintain the structure and functions of a system are emphasised in this definition, resilience is also a measure of the adaptive and transformative capacity of the system. This definition also requires modification for its use in biosecurity. Preventive capacity must be part of the definition of biosecurity resilience. Vulnerability and resilience are not antonyms - they are

different but complementary concepts focused on a different scale and aspects of a system. Vulnerability often focuses on individual units and weaknesses of the system, while resilience has often had system-level focus and attributes of strength and persistence of systems.

In this presentation, I propose a linked vulnerability-resilience assessment framework that assists with identifying the type and nature of the change required for resilient biosecurity capable of delivering value under plausible future scenarios of different threats. The linked assessment helps avoid an approach that seeks only weaknesses (deficit model) or a focus on strengths that overlooks weaknesses in the system. This assessment together with plausible biosecurity threat scenarios provides an evidence base for identifying what interacting parts of the biosecurity systems to maintain, and what parts to modify or transform. Transformation can take time and this assessment provides guidance on what actions to put in place now to ensure the desired transformational change in the future. I demonstrate how the linked vulnerability-resilience assessment framework can be applied to assess animal health biosecurity, building on recent work on vulnerability as an overarching concept to characterise farmers based on their level of susceptibility to TAD and drawing from the extensive rural resilience research experience.

Giving animal pests and diseases the chop. Implementing biosecurity planning into NSW abattoirs and knackeries.

F McDonagh[1], P Phillips[1], N Schembri[1],

[1]NSW Department of Primary Industries

fiona.mcdonagh@dpie.nsw.gov.au

Abattoirs and knackeries are instrumental in the detection of notifiable endemic and emergency animal disease (EAD) events, playing a key role in frontline disease surveillance.

In 2020, MINTRAC conducted a national training program, funded by the Commonwealth to address EAD awareness and preparedness gaps in domestic processing plants.

With EAD planning forming one component of a complete Biosecurity Management Plan (BMP), an opportunity was identified to introduce biosecurity management to these meat processors. The NSW Department of Primary Industries (NSW DPI) led the development and implementation of BMPs *and* *Business Continuity Planning* in domestic abattoirs and knackeries in NSW.

The NSW DPI and Local Land Services with domestic processing plant representatives developed in collaboration an informative and actionable benchmark BMP that can be specifically tailored to a plant's operations. All licensed abattoirs and knackeries were informed on the program's formal implementation via a *General Circular - Biosecurity Management Plan implementation for abattoirs and knackeries* in February 2021.

To support licensees, an online quarterly abattoir and knackery industry group meeting has since been established to discuss current and evolving issues relating to the industry with government and other industry stakeholders.

With 13 domestic red meat abattoirs and 6 knackeries currently licensed in NSW, the initial aim was to implement BMPs into 25% of licensed premises to help these businesses apply measures that reduced their operative biosecurity risks and put measure in place to support business continuity during an emergency event.

As of June 2021, eight facilities (42%) returned completed plans. All abattoirs and knackeries will have their BMPs inspected for the first time in 2021. BMP inspections will form a third tier in current and ongoing requirements of domestic abattoir and knackery

plants alongside food safety and animal welfare monitoring to ensure our domestic plants continue to maintain sound biosecurity practice.

“Shut the gate” on hitchhiking pests. Building local council capacity to protect our natural environments

F McDonagh[1], T Syphers[1], N Schembri[1], N Gill[2]

[1]NSW Department of Primary Industries

[2]Greater Sydney Local Land Services

fiona.mcdonagh@dpie.nsw.gov.au

Introduction:

Local Land Services (LLS), NSW Department of Primary Industries (NSW DPI) with the Department of Agriculture, Water and Environment previously held workshops for local governments surrounding Port Botany on the recognition, surveillance and reporting of cargo pests, priority exotic plant pests and new incursion species. Over time, the incidence and spread of these pests expanded throughout Greater Sydney.

Aim:

- To understand local council’s awareness of biosecurity, their willingness to participate in “Gateway Pest” training and their preferred communication and training tools.
- Develop an online training program to support exotic pest, weed and disease detection and reporting in councils in NSW.

Method:

An online survey was developed by NSW DPI and LLS using human-centred design methodology and sent via direct email to known council stakeholders, environmental groups and golf courses located along known high-risk pathways.

Results:

The survey (N=13) highlighted attitudes and barriers to biosecurity, training, and engagement with exotic pest surveillance. Using the survey findings, the project team engaged a graphic recorder to design a set of characters and environments that directly related to the target stakeholders (councils).

A training package of six modules was developed for local council staff in Greater Sydney, employed in the outdoor maintenance and operations teams on exotic (gateway) pest biosecurity, surveillance, and reporting.

Conclusion:

Timely detection and reporting are key to successfully eradicating an exotic pest or a disease incursion. Early engagement with council, tailoring the messages and developing relatable and bespoke graphics in the e-learning program has been critical. Additional characters developed and included in the program provide further flexibility to extend

the training to environmental industries and community groups drive biosecurity engagement and action. Biosecurity is everyone's responsibility and we need everyone's eyes and ears, to 'shut the gate' on these exotic pests and disease to protect what we love.

Grower Managed Plant Protection and Biosecurity Systems

J McDonald [1]

[1]Greenlife Industry Australia

john.mcdonald@greenlifeindustry.com.au

'**BioSecure *HACCP***' has been developed to assist growers improve on-site plant protection and biosecurity while strengthening domestic market access. BioSecure *HACCP* delivers significant on-farm plant protection and biosecurity benefits to growers through this integrated cropping system as well as efficiency benefits to the regulator while reducing plant pest risks to industry, environment and the community. This is achieved through robust and detailed on-farm biosecurity procedures, electronic data management, domestic market access certification and traceability with overall pest risk reduction along the supply chain.

BioSecure *HACCP* is a structured on-farm crop monitoring, surveillance and inspection system that is robust, technically valid and adaptable to the production cycles of containerised plant production utilising high health cropping practices/procedures under Best Management Practice (BMP). Combining on-farm biosecurity procedures with pest specific movement controls BioSecure HACCP is a legal market access scheme, nationally supported by all jurisdictions, for the interstate and intrastate movement of nursery stock through self-certification.

The system is independently audited, twice per annum, to ensure businesses maintain their on-farm biosecurity systems, skill sets and compliance for market access. The on-farm program operates under the electronic 'Audit Management System' with growers storing compliance records in their secure on-line portal as well as having the capability to generate biosecurity certificates electronically for market access validation. Using BioSecure HACCP as a legal interstate/intrastate market access system has been agreed and accepted by all Australian state and territory biosecurity agencies.

BioSecure HACCP certified businesses are able to use the system for interstate/intrastate market access through self-certification that confirms the specific entry condition(s) of the receiving jurisdiction have been met by the business (Entry Condition Compliance Procedure (ECCP)). This replaces the current government managed market access processes of either a plant health inspector certified consignment or the implementation of a government developed ICA/CA procedure and self-certified consignment.

The scientific effort underpinning current efforts to eradicate Red Imported Fire Ant from Australia

A McLennan[1]

[1] National Red Imported Fire Ant Eradication Program, Department of Agriculture and Fisheries

austin.mclennan@daf.qld.gov.au

Originating from South America, the red imported fire ant (RIFA), *Solenopsis invicta* Buren, is an highly invasive ant species with the potential to cause major negative impacts on native vertebrate and invertebrate fauna and human health, and significant economic losses in agricultural and urban areas. After it was detected in south-east Queensland in 2001, RIFA became the target of a sustained eradication program to dislodge it from Australia.

Since the program's inception, efforts have been made to ensure that it is underpinned by science, i.e. by an understanding of the biology of the species and the optimal levels and methods of surveillance and treatment to achieve eradication. The need for specialist scientific input crosses virtually all areas of the RIFA eradication program, including: diagnostics; surveillance (e.g. through support of sniffer dog, remote sensing and community engagement activities); treatment (by recommending and evaluating the effectiveness of various treatment methods); compliance (to reduce the risk of human-assisted movement of fire ants, e.g. by providing technical advice and risk assessments for various industry sectors); strategic planning (through modelling and mathematical optimisation) and overall progress evaluation (e.g. through world-leading genetic studies).

To this end, a unit of entomologists and scientific technical staff has been a consistent part of the organisational makeup within the RIFA eradication program, providing specialist advice, technical support and targeted research and analysis to program management. This paper provides an overview of the ways in which this science unit has contributed to the design and execution of the program so far, with a focus on new and emerging priorities for research and scientific input into the National RIFA Eradication Program.

Using honey bees and genomics to monitor vegetation changes and detect multiple target species

L Milla[1], J Roberts[1], F Encinas-Viso[1]

[1]Commonwealth Scientific and Industrial Research Organisation

Liz.milla@csiro.au

Effective monitoring of terrestrial biodiversity is a growing challenge, as factors such as urbanisation, global movements and climate change combine to drive some species to extinction and facilitate the spread of others. Tracking vegetation changes is typically done via in-person surveys, a costly and time-consuming approach. Consequently, the detection of introduced or invasive plants within Australia's complex habitats remains an ongoing problem.

New genomic methods can provide fast and reproducible results for environmental monitoring. We applied DNA metabarcoding to pollen from European honey bees (*Apis mellifera*) and examined their foraging sources within an urban reserve in Canberra. We used pollen from individual bees, honey and pollen traps to identify plant species found in pollen DNA. We compared the results to plants recorded by a ground vegetation survey. Additionally, we applied metabarcoding to pollen cell pellets taken from six hives located around Australia and PNG to determine whether the bees' pollen foraging could differentiate between hive locations and potentially detect invasive species.

Pollen metabarcoding detected 74 taxa vs. 44 taxa recorded by the reserve survey, with the combined results of 20 bees detecting as many taxa as the survey. Metabarcoding also identified 25% of the genera and 9% of the species recorded by our survey. Pollen metabarcoding of the cell pellets (using PCoA and ITS2) was able to group together hives from Canberra and differentiate the other hives.

We demonstrate that DNA metabarcoding of pollen foraged by honey bees can detect higher numbers of taxa than ground surveys. Common weed species such as thistle (*Onopordum acanthium*), red valerian (*Centranthus ruber*) and great mullein (*Verbascum thapsus*) were detected with metabarcoding from cell pellets, demonstrating great potential to detect multiple invasive species from individual samples. This molecular approach is highly scalable, repeatable and can be easily adapted to ongoing monitoring of vegetation.

Fishing the deep web- illegal trade in an unregulated industry

M D Millington[1], B J Holmes[2], S R Balcombe[1]

[1]Australian Rivers Institute, Griffith University, Sir Samuel Griffith Building (N78 4.27) 170 Kessels Rd, Nathan QLD 4111 Australia.

[2]School of Science, Technology and Engineering, University of the Sunshine Coast, 90 Sippy Downs Rd, Sippy Downs QLD 4556 Australia.

mariahmillington24@gmail.com

With significant volumes of non–native freshwater fish transported globally for ornamental trade, effective biosecurity management and compliance measures are critical. Active management, as opposed to traditional passive management currently routine in Australia, is vital for protecting our aquatic ecosystems from ornamental invasion and subsequent environmental, social, and economic impacts. However, active management of the ornamental community is unachievable without a sound understanding of the species already in trade. This list is an important first step in understanding the threat from this industry through risk assessing traded species to identify their invasive potential and hence their import admissibility and legality. In recent work, we identified that records of captive freshwater fish species in published scientific literature are rudimentary and unable to be utilised to produce a comprehensive trade list. We therefore cannot rely upon previous research to adequately represent the traded community in Australia. Instead, direct trade surveys are needed. In particular, the wealth of data present in online pet stores and social media sites remains relatively untouched. Online monitoring has become a core tool for ornamental research internationally, aiding scientists and managers in the compilation of comprehensive trade lists that improve understanding of non-native species traded and where potential incursions may occur.

As part of my PhD research, we monitored aquarium stores and ornamental hobbyist groups over several months to record online trade of freshwater fish in Queensland, Australia. A considerable ornamental community emerged, involving thousands of participants from all around Queensland advertising and transporting hundreds of species online including highly invasive and restricted fish. In my presentation I will shine a light on the deep web and the real biosecurity threat this prosperous and prolific community poses to our freshwater ecosystems.

Identification of biomarkers of myrtle rust infection and resistant germplasm using metabolomics methodology

M C Moffitt [1], J Wong-Bajracharya [1,2],D W Coles[1], L Shuey[3], J M Plett[1]

[1]Western Sydney University, Sydney, NSW

[2]NSW Department of Primary Industries, Menangle, NSW

[3]Department of Agriculture and Fisheries - Queensland Government, QLD

m.moffitt@westernsydney.edu.au

Myrtle rust is an exotic disease caused by the fungal pathogen, Austropuccinia psidii, which is known to infect Myrtaceae plants. In Australia alone, the Myrtaceae are dominant in most ecosystems and overall more than 2250 species have been recorded and as such, A. psidii infection is a significant threat to Australian ecosystems. To date, 382 native Australian species are known to be vulnerable to A. psidii infection, however, within each species, a range of responses to infection can be presented, from highly susceptible to hypersensitive and resistant. Since its incursion in Australia in 2010, only a single species of A. psidii has been reported along the east coast, however, other strains of the fungus have been reported overseas and these novel strains remain a threat to Australia's biosecurity.

Metabolomics is the assessment of small molecules (metabolites) in a biological sample. In this study, we explored the use of metabolomics as a novel technology that can be deployed as a rapid screening tool to detect biomarkers of the plant host response during progression of disease and identify differences between germplasm that may be resistant, hypersensitive or susceptible to the disease.

Using Melaleuca quinquenervia in a foundational study, we confirmed that metabolomics can be developed as a sensitive method for detecting biomarkers of A. psidii infection in the first 48 hours, regardless of susceptibility to infection. Additionally, metabolomics was effective in differentiating resistant, hypersensitive and susceptible phenotypes prior to- and in the early stages of infection. Follow up experiments in Eucalyptus grandis confirmed metabolomics can be applied to other Myrtaceae. Our results indicate that rapid screening for metabolomic biomarkers can be used to identify early disease and is essential to prevent new incursions, limit spreading events and to identify resistant germplasm for targeted specimen collection and plant breeding programs.

An integrated approach to biosecurity – a shared vision for North Australia

C Morton[1], G Owens[2], D Peck[3], A Anau[3], M Ashton[4] and Bluey Stoldt[5]

[1]Department of Industry, Tourism and Trade, Darwin, NT

[2]NT Farmers Association, Darwin, NT

[3]Commonwealth Department of Agriculture, Water and the Environment, Cairns, QLD

[4]Department of Agriculture and Fisheries, Brisbane, QLD

[5]Organic AG

claire.morton@nt.gov.au

Northern Australia (NA) is the gateway to mainland Australia and is exposed to biosecurity risks through the movement of animal and plant pests via a range of pathways from our close neighbours. The NA biosecurity system needs to be robust and strong to reduce the risk of exotic pest incursions through natural pathways, as well as market access and trade. Northern Australia faces many challenges due to its increased primary production, considerable development potential, sparse population, and large and remote geographic location.

To manage the risks to the biosecurity system, it is critical that government, industry and other stakeholders (e.g. ranger groups) work collaboratively and share responsibility for keeping the region free from exotic plant pests. Collaboration is underpinned by the Northern Australian Biosecurity Strategy. This is an overarching roadmap towards better biosecurity outcomes for partners in the north. A Memorandum of Understanding (MoU) exists between the Commonwealth, Western Australia, Queensland and the Northern Territory.

The objectives of the MoU are to:

- facilitate and support new investment in Northern Australia
- build human capacity and capability to manage risks and respond to exotic pest incursions
- collaborate and share resources to enhance outcomes (infrastructure, technologies, diagnostics, surveillance, communications and engagement)
- assess and prioritise key pests and movement pathways to maximise joint effort

The Panel will articulate the challenges, offer solutions and discuss shared success. Outcomes were achieved, not only in the eradication of the pest/s, but in the strong

relationships that were established and have helped enable a shift in collaborations to ensure minimal disruption to trade for growers. Stakeholders are also working together to enhance biosecurity in preparedness, pest awareness, early detection surveillance activities and research. The Panel will highlight opportunities for ongoing collaborations in multiple areas so that good biosecurity outcomes for NA can continue to be realised.

Literally connecting dots: a collaborative approach to invasive species data integration and modelling for national benefit

K Ng[1], JG Froese[2], S Foster3, M Hill[4], G Hosack[3], A Hoskins[5], M Keighley[1], D Mitchell[1], K Proft[1], P Tennant[1]

[1]Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), Canberra, ACT

[2]CSIRO Health & Biosecurity, Dutton Park, QLD

[3]CSIRO Data 61, Hobart, TAS

[4]CSIRO Health & Biosecurity, Canberra, ACT

[5]CSIRO Health & Biosecurity, Townsville, QLD

katherina.ng@awe.gov.au; jens.froese@csiro.au

Significant economic costs have been attributed to direct damage and losses from invasive species that are well-established and widespread in Australia. Established pest animals, weeds and diseases also have devastating environmental impacts, being the number one threat to vulnerable native species in Australia. It has long been recognised that a shared, coordinated approach to managing the negative impacts of established invasive species is required. However, sharing invasive species management between multiple levels of government, natural resource management, industry and community stakeholders has resulted in a highly fragmented data landscape. This is due to invasive species data being collected with different methods and sampling protocols, and at varying geographic and temporal scales. Bringing these disparate data together into reliable information products that facilitate cross-jurisdictional decision-making is an important unaddressed challenge.

In the National Vertebrate Pests and Weeds Distribution Project, ABARES and CSIRO are working with stakeholders across the biosecurity system on a collaborative approach to collecting, sharing and using data to better understand pest animal and weed distribution and impact nationally. ABARES is engaging with stakeholders to assemble and rigorously document a national data inventory, and to establish data sharing and governance approaches that help break down institutional barriers to effective national coordination of invasive species data. CSIRO is developing analytical methods for modelling pest animal and weed distributions from disparate data. Our integrated species distribution modelling method is designed with flexibility and transferability in mind. It will be delivered as an open-source package containing documented modelling

workflows and example applications. This delivery approach will enable future application of our method to a range of biological, geographical and data contexts. Ultimately, national data integration based on a collaborative approach will enable decision makers to more effectively allocate resources, assess effectiveness of investments, and improve management outcomes.

This project is funded through the Established Pest Animal and Weed Management Pipeline Program by the Australian Government.

Exotic Environmental Pests – Addressing Persistent Risk

A. Pearce[1]

[1]Environmental Biosecurity Office | Department of Agriculture, Water and the Environment

Canberra, ACT

Andrew.pearce@awe.gov.au

The National Priority List of Exotic Environmental Pests, Weeds and Diseases (EEPL) has been established since 2020. The list is comprised of 168 species covering a broad range of taxa that are partitioned into eight biological categories:

- Aquatic animal diseases
- Freshwater invertebrates
- Marine pests
- Native animal diseases
- Plant diseases
- Terrestrial invertebrates
- Vertebrates
- Weeds and freshwater algae.

To qualify for listing as an EEPL species it must:

- be an exotic species to Australia,
- not be an established exotic species unless it is part of an ongoing eradication program,
- be assessed as a significant risk to the environment or to associated social amenities.

The top 5 or 6 highest risk species from each biological category form an EEPL subset of 42 species referred to as the "higher risk EEPL".

A program of work has been developed, involving a series of national consultations, as part of the EEPL Implementation Plan. The plan sets out work the Environmental Biosecurity Office (EBO) will undertake as capability development projects to reduce environmental biosecurity risk and in support of existing stakeholder programs.

The higher risk EEPL will be the priority for work under the EEPL Implementation Plan. Due to biological and pest entry pathway similarities - risk mitigation measures aimed at higher risk EEPL species will also reduce the risk of lower priority EEPL species and will also reduce the environmental biosecurity risk of other similar species not listed on the EEPL.

The progress of these national level objectives will depend upon help from state and territory counterpart biosecurity agencies and NGOs and community groups.

The program of work in the EEPL Implementation Plan will also be progressed through the funding of suitable projects that meet the appropriate criteria under the Environmental Biosecurity Project Fund (EBPF). EBPF funded projects will aim to improve Australia's capacity to prevent pest entry into Australia, detect and identify pests, and to prepare for and respond to incursions of exotic environmental pests, weeds, and diseases.

Mission: Biosecurity Be a part of it

S Perkins [1], F Fahri[1], T Syphers[1], C Roach[1], E Rucker,[1]

[1] NSW Department of Primary Industries

Sus.perkins@dpi.nsw.gov.au

Introduction:

With an increasing number of new and ongoing threats to Australia's biosecurity systems, an opportunity to engage the broader community about the impact these threats pose to our environment, economy and communities, including the role we all play role in mitigating these risks, was identified.

NSW Department of Primary Industries (NSW DPI) in collaboration with Departments of Agriculture and Primary Industries across Australia, proudly partnered with Costa Georgiadis of Gardening Australia and the producers of Dirt Girl World to develop a national biosecurity digital campaign, Mission: Biosecurity.

Aims:

Mission: Biosecurity aims to:

- bolster our digital engagement to drive community awareness and help promote the benefits of strong biosecurity in Australia,
- educate a broad range of audiences about biosecurity, as well as highlight each of the participating jurisdiction's priorities and
- provide nationally consistent biosecurity messaging and approach.

Outcomes:

Mission: Biosecurity is a suite of interactive digital and educational resources hosted on an independent website that showcase the importance of good biosecurity across Australia. These resources were developed to be used nationally throughout 2020-21 to promote biosecurity, its impact on our way of life and to demonstrate and reinforce how we can all help protect our economy, environment and communities from the threat and negative impact that biosecurity 'baddies' pose. The resources also showcase the vital work biosecurity staff and researchers undertake across the country.

The resources were developed to engage with multiple learning preferences, are based on vocational education and training design principles and draws from the learnings

from targeted pre-adolescent focus groups. This approach ensures the materials were fit for purpose and audience, irrespective of age and learning capacity.

At its launch in November 2020, the bespoke Mission: Biosecurity website comprised:

- 11 interactive online based games and quizzes
- Ten mini-videos, each of 1-2 minutes duration
- Six audio podcasts of 10 – 40 minutes duration.

Join the mission at www.missionbiosecurity.com.au.

Farm Location Image Processing: Using deep learning to differentiate livestock farms from aerial imagery

C Pfeiffer [1], J Garber[2], S Firestone[1,] Z Joukhadar[2], N Faux[2], K Sheffield[3], A Dodd[4], K Spreadborough[2], M Stevenson[1], J Hunnam[5]

[1]Melbourne Veterinary School, The University of Melbourne, Parkville, VIC

[2]Melbourne Data Analytics Platform, The University of Melbourne, Parkville, VIC

[3]Agriculture Victoria, Victorian Department of Jobs, Precincts and Regions, Bundoora, VIC

[4]Centre of Excellence for Biosecurity Risk Analysis, The University of Melbourne, Parkville, VIC

[5]Agriculture Victoria, Victorian Department of Jobs, Precincts and Regions, Attwood, VIC

caitlin.pfeiffer@unimelb.edu.au

Introduction

In an emergency animal disease incursion, such as an outbreak of African swine fever or avian influenza, accurate classification of current land uses for different types of livestock farming are needed to facilitate an effective response. At present, records in key land use and property identification datasets have discrepancies and omissions that limit their effective use during a biosecurity response. This was highlighted during the 2020 avian influenza response in Victoria.

Aims

This project aims to use existing high-resolution aerial imagery of rural Australia along with deep learning methods (convolutional neural networks, CNNs) to accurately predict the livestock species on individual farms based on existing infrastructure, including commercial poultry, commercial pig, dairy and finfish farms as well as smallholder pigs.

Methods

The project implements a CNN algorithm trained to classify multiple livestock farm types simultaneously. The algorithm leverages techniques including transfer learning and image augmentation to accommodate a modest image dataset size, making CNN feasible even if thousands of example images are not available. Multiple candidate model architectures have been compared to determine the model that can most accurately predict the types of livestock present on-farm.

Results

The CNN classifier has shown promising early results. The model performs well when differentiating poultry, commercial pig and dairy farms, with recall (a metric measuring the proportion of correct predictions) above 70%. Backyard pigs are a more challenging task, with model recall around 50%.

Conclusions

The long-term aim of this project is to produce a tool that can be used by government departments to rapidly classify farm types before or during an emergency disease response. The results can inform risk assessments and outbreak containment and control activities, helping governments know where the animal populations under threat are located, saving time and allocating limited resources effectively, and thus protecting Australia's valuable disease-free status.

Defining behaviour change priorities for biosecurity

K Phillips [1]

[1] Biosecurity Queensland, Department of Agriculture and Fisheries Queensland Government

Kirsten.phillips@daf.qld.gov.au

Creating a biosecurity awareness base

With a crowded communication space, multiple overlapping biosecurity threats and finite resources, how do we create an effective behaviour change program that overcomes these challenges? Biosecurity Queensland is working to redefine its behaviour change priorities and emerge with a new content strategy and engagement approach. Taking an evidence-based approach and drawing on a broad base of biosecurity expertise, this project has allowed Biosecurity Queensland to identify high priority behaviours and audiences cutting across the plant, animal, invasive and environmental biosecurity space.

Through this body of work, Biosecurity Queensland is now refining how it approaches not only its delivery of behaviour change campaigns, but its organisational content strategy and overall engagement. This content strategy defines clear information pillars for the organisation and guiding principles that refine our approach to communicating and engaging with our audiences.

The outcomes of this work include:

- a strong baseline of biosecurity awareness around priority high-risk biosecurity behaviours,
- improved engagement with the highest risk audiences with an approach of reinforcing wholistic positive behaviours that produce improved biosecurity outcomes, and
- a more consistent approach to content generation and messaging across Biosecurity Queensland.

Biosecurity Queensland is now embarking on a new program of projects that aligns to this direction and takes into account the operational, strategic and engagement shift that is needed to achieve results. Our learnings and projects have the potential to benefit other government agencies and industry within the biosecurity system and Queensland is keen to partner with other organisations in delivery of this work.

East and West - working together to disentangle FAW global introduction pathways

R V Rane[1,4], T K Walsh[2,4], K H J Gordon[2], S Downes[3], S Macfadyen[2], **W T Tay**[2,4]

[1]CSIRO, 343 Royal Parade, Parkville, VIC 3052, Australia

[2]CSIRO Black Mountain Laboratories, Clunies Ross Street, ACT 2601, Australia

[3]CSIRO McMaster Laboratories, New England Highway, Armidale, NSW 2350, Australia

[4]Applied BioSciences, Macquarie University, Sydney, NSW, 2109, Australia

weetek.tay@csiro.au

The fall armyworm (FAW) Spodoptera frugiperda, a major agricultural crop pest native to the Americas, is now reported from over 78 countries and represents a significant threat to national economies and food security especially in Africa, Asia, and Southeast Asia (SEA). The spread of FAW has been hypothesised to originate from a single incursion of a small population in west Africa in early 2016, and followed a west-to-east anthropogenic-assisted and natural spread pathway. An alternative hypothesis is that current invasive FAW populations represent in parts, multiple independent introductions from diverse native populations. This is reflected by anecdotal reports that FAW was in these regions prior to 2016, and therefore likely involved a bidirectional spread pathway. At the population level, distinct homogeneous cf. heterogeneous genomic signatures are expected to be associated with the west-to-east or the east-to-west hypotheses, respectively. We aim to understand the incursion pathways of FAW by exploring international collaboration to address shared biosecurity challenges.

467 FAWs representing the species' invasive (36 populations (13 countries) from Africa, Asia, SEA, Oceania) and native (nine populations (seven countries) from North, Central, South Americas, and Caribbean) ranges were whole-genome sequenced. 890 neutral genome-wide single polymorphic markers were selected for analyses to test the competing hypotheses.

Genome heterogeneities in the geographically disparate invasive populations supported the multiple independent introductions hypothesis, and highlighted the role of bilateral movements to underpin their perceived rapid global spread. The benefits of east-west partnerships between industries, NGO's, private and government organisations to disentangle incursion pathways are demonstrated. As an emerging pest threat, the FAW therefore epitomises how better emergency preparedness might have prevented or slowed its global expansion. There is a need to mitigate political sensitivities relating to

market access and open communication, and to improve biosecurity preparedness through timely biosecurity detection reporting especially on emerging pests.

Plant health in One Health – absolutely critical for safeguarding life

L Ransom PSM[1]

[1]LMR Consulting

Loisransom@yahoo.com

The concept of One Health has been around for several decades and has traditionally been applied to managing the risks of development and transmission of zoonotic diseases between animals and humans. The COVID-19 pandemic has promoted awareness of the role of the environment in the development of zoonoses and the subsequent risk of pandemics. The promotion of a One Health concept that integrates the environment must include the fundamental contribution of plant health to reduce the risk of future pandemics through protecting ecosystems from the international movement of plant pests and their impacts; reduce the risks and impacts of antimicrobial resistance arising from broadacre crop protection practices; and facilitate the safe movement of food and feed around the world as the basis for food security. Plants provide 80% of human food and up to 100% of livestock feed. They release oxygen and fix carbon dioxide. They are the basis of life on earth.

The integration of plant health into One Health need not, initially, pose either significant change or challenge. National and international actions to safeguard biosecurity by preventing entry and establishment of exotic plant pests will continue. The development of international standards to facilitate harmonisation of phytosanitary measures and safe trade will also continue. However, the context for these activities should change to ensure that the protection of plant health, and from it, safeguarding biodiversity and natural, production and urban ecosystems, are recognised as critical to pandemic prevention, preparedness and response. Not all the many international programs arising from the pandemic need to integrate plant health expertise, but where plants are a critical element, ensuring their health will only enhance the efficacy of program outcomes.

Inspiring action: mobilising industries and communities to take up fire ant treatment

K Retzki[1]

[1]National Red Imported Fire Ant Eradication Program

kate.retzki@daf.qld.gov.au

For almost 20 years the National Fire Ant Eradication Program's message was clear, "If you have fire ants, report and we'll take care of them". However, in the last 12 months we've seen fundamental change.

It has become clear that to be successful in the fight against this pest, a whole-of-community approach is needed. So, we've launched seven projects working alongside industry and community, mobilising them to manage fire ants on land they own.

What have we learned? Make it easy. By reducing barriers, building understanding and leveraging local capacity, we are empowering stakeholders to share the responsibility.

Thousands of South East Queensland residents have taken up the fight in their neighbourhoods. This is significant buy-in towards region-wide behaviour change. At the same time, local councils, sports clubs, schools, cane farmers and other primary producers have also started to take an active role in fire ant management.

These pilots are demonstrating that we can come together with community and industry on biosecurity matters.

In the next 12 months we will bring further enhancements, with plans to scale up community fire ant treatment. We'll work on new ways to reduce obstacles relating to the accessibly of fire ant treatment and work to strengthen the community's capabilities to self-manage their land.

Supply Chain Operational Preparedness - Abattoir Biosecurity Controls

K Richards[1], A Pointon[2], R Cutler[3,5], M Bayer[4]

[1]SunPork Group, Brisbane, QLD

[2]Pork SA, West Lakes, SA

[3]Ross Cutler & Associates, Ocean Grove, VIC

[4]Big River Pork, Murray Bridge, SA

[5]Australian Pork Limited, Kingston, ACT

kirsty.richards@sunporkfarms.com.au

Introduction

Disruption to operating efficiencies and pig movements by the incursion of and response to African swine fever (ASF) will have immediate and rapidly escalating impacts on pig welfare, supply chain continuity and supply of pork to consumers. It is expected that it may take some weeks to detect and diagnose ASF in the index herd. It is probable that at least one of seven abattoirs that process >95% of pigs will become contaminated leading to closure. Consequentially, the extent of tracing and movement restrictions may be substantial. For every 1 week any single major processing plant is closed, it will take 4-5 weeks to catch up.

Abattoir biosecurity is critical in the Response and Recovery to an ASF incursion by:

1. reducing the spread of disease, number of trace premises and extent of movement restrictions,
2. supporting rapid re-establishment of supply chain capacity when disruption does occur.

Because of these supply chain characteristics, greater emphasis on abattoir biosecurity in AUSVETPLAN is a priority.

Method

In 2021 a pork industry-led, collaborative working group including representatives from export pig abattoirs, Department of Agriculture and Environment (DAWE), Biosecurity South Australia and members of Australian Pork Limited's (APL) ASF Technical Panel applied a Hazard and Critical Control Point (HACCP)-based ASF biosecurity exposure assessment to pork abattoirs to establish biosecurity controls.

Results and Discussion

Outputs include:

1. prioritised biosecurity control and verification activities for:
   a. resolution of an abattoir classified as a dangerous contact processing facility (DCPF) or infected premises (IP)
   b. operation of an abattoir as an approved processing facility (APF)
   c. depopulation of infected herds
2. biosecurity checklist for resolution of a DCPF and operation as an APF,
3. comprehensive ASF biosecurity control/verification template for adaptation and adoption on an abattoir-by-abattoir basis,
4. a list of unresolved policy and technical issues requiring further work.

This assessment recognises:

- the critical dependency of the Australian pork industry supply chain on minimising the role of processing plants in the spread of disease,
- the value of understanding actions that a processing plant must undertake if it is involved in a disease outbreak to resolve contamination and function as an APF and,
- the value of establishing an abattoir pre-assessment in "peacetime" to prepare for accreditation as an Approved Processing Facility during an EAD response.

Honey bee surveillance as a tool for integrated biosecurity

J Roberts[1], F Encinas-Viso[1], L Milla[1], A Geeering[2]

[1]Commonwealth Scientific and Industrial Research Organisation, Canberra, ACT

[2]University of Queensland, St Lucia, QLD

john.roberts@csiro.au

Honey bees provide essential pollination services across the agricultural landscape and can also deliver unique surveillance of the environment for a range of biosecurity threats. Australia's national sentinel hive program monitors high risk ports of entry for honey bee biosecurity threats, e.g. Varroa mites and bee viruses. However, foraging honey bees collecting nectar and pollen are also interacting widely with the local environment. Molecular testing (high-throughput sequencing or targeted PCR) of honey bees, bee-collected pollen and honey are an excellent source for detection of a range of bee and plant pathogens and weed species.

Here we present three case-studies where we have demonstrated the potential of this approach to detect plant viruses of biosecurity interest. Our first example describes the early detection of cucumber green mottle mosaic virus (CGMMV) from high-throughput sequencing during a national bee pathogen survey. Our second example used sentinel hives from the National Bee Pest Surveillance Program to detect several potential exotic plant viruses and included pollen metabarcoding to identifying the plants visited by foraging bees. Our third example explored the application of this method for surveillance of avocado sunblotch viroid during orchard pollination.

From these examples we will discuss how honey bee surveillance can become a valuable tool to enhance cross-sectorial integration of the biosecurity system.

A high-level approach to assessing pests and pathways

A P Robinson[1], M. Ormsby[2]

[1]University of Melbourne, Melbourne, VIC

[2]Ministry for Primary Industries, New Zealand.

apro@unimelb.edu.au

Introduction

The biosecurity system faces increasing pressure from significant increases in goods and passengers, changing pathways and types of goods. All activities of the system need to work together cost-effectively to maximise the reduction of biosecurity risk under sharply constrained resources. To increase the efficiency of biosecurity investment and to identify opportunities for substantial improvement, the Ministry for Primary Industries (MPI) is determining the relative contribution of biosecurity risk management activities toward system effectiveness.

Aims

This project is one in a suite that provides a framework to evaluate the comparative value of biosecurity activities implemented at intersecting sites across a matrix of entry pathways and across layers of the system. Earlier work developed a framework for terrestrial pests, with a case study for gypsy moth. This presentation covers the development and parameterisation of the structural biosecurity risk management model for a marine pest, namely brown mussel (Perna perna).

Methods

Briefly, such a model comprises a likelihood module, which represents pre-border and border exposures and risk management, and a consequences module, which represents impacts and post-border activities. The model is parameterized using a combination of structured expert judgment and data.

Results

1. The total exposure due to biofouling is estimated at more than six times higher than the total exposure due to ballast discharge.

2. Yachts are predicted to be heavy-exposure pathways.

3. The establishment risks seem highest to Auckland and Tauranga because of their greater exposure via the biofouling (in particular) and ballast water discharge pathways.

4. Invasive populations of brown mussel are very unlikely to be detected before they reach a size that would render eradication prohibitively expensive, although this has happened previously.

5. The potential benefits from unspecified counterfactual targeted surveillance relative to the current surveillance setting are predicted to be negligible.

Making a difference to Myrtle Rust in Australia: highlighting the Plant Biosecurity Science Foundation's co-investments.

M Robinson[1]

[1]Australian plant Biosecurity Science Foundation

Michael.robinson@apbsf.org.au

The Australian Plant Biosecurity Foundation was formed out of the Plant Biosecurity CRC, with a mission to invest, co-invests and partner on RDE, delivery and capacity building for plant biosecurity in Australia. We chose a focus on environmental biosecurity, where our Board felt we could make a real difference.

Myrtle Rust is a plant disease caused by the introduced fungal pathogen *Austropuccinia psidii* and it poses a serious and urgent threat to Australia's native biodiversity. Myrtle Rust affects plant species in the family Myrtaceae (paperbarks, tea-trees, eucalypts, and lillipillies), which are key and often dominant species in most Australian ecosystems. The Foundation inherited the draft National Myrtle Rust Action Plan in 2018.

Since then the Foundation has co-invested in 16 key Myrtle Rust projects with its partners, finalized and released the Myrtle Rust National Action Plan, and held the Myrtle Rust National Symposium in 2021, and developed a Statement of Concern.

The projects cover a variety of topics including:

- pre-border vigilance for exotic strains
- a surveillance strategy for WA
- examining host susceptibility
- expanding community and indigenous capacity for knowledge, surveillance and monitoring
- resolution of disease epidemiology and detection of genetic and genotype diversity
- the impact of Myrtle Rust on regeneration in fire damaged ecosystems
- exploration of RNAi vaccines to control Myrtle Rust.

This talk will cover the highlights of the Foundation's investments in Myrtle rust since 2018, and emphasize the need for continued investment and nationally coordinated action.

An Implementation Plan for the application of High Throughput Sequencing (HTS) as a biosecurity tool.

B Rodoni[1], A Dinsdale[2], J Oakey[3], S Hair[4], T Chapman[5], M Kehoe[4], D Bogema[5], M Blacket[1], B Fargher[3], M Blankenberg[3], K Halpin[6]

[1]Agriculture Victoria, AgriBio, 5 ring Rd, La Trobe University, Bundoora, Victoria

[2]Department of Agriculture, Water and the Environment. Post-Entry Quarantine Facility, 135 Donnybrook Rd, Mickleham, Victoria

[3]Biosecurity Queensland, Queensland Department of Agriculture and Fisheries

[4]Diagnostics and Laboratory Services, Department of Primary Industries and Regional Development, 3 Baron-Hay Court, South Perth, WA, 6151

[5]NSW Department of Primary Industries, Elizabeth Macarthur Agricultural Institute, Menangle, NSW 2568, Australia

[6]Australian Centre for Disease Preparedness, CSIRO, 5 Portarlington Road, East Geelong, Victoria 3219, Australia

brendan.rodoni@agriculture.vic.gov.au

High Throughput Sequencing (HTS) is a disruptive technology that has been used as a powerful research tool for over a decade and is increasingly being used to support diagnostic outcomes in the laboratory. HTS can be used for pest and pathogen detection, genome characterisation and genomic epidemiology. However, there are currently no standards or guidelines available for diagnosticians to use to ensure HTS generates accurate diagnoses and there are no national systems in place to promote sharing of diagnostic data between biosecurity agencies. The National Biosecurity Committee recognised HTS as a priority biosecurity area in 2019 and recommended that a strategic roadmap be developed to progress the application and adoption of HTS as a diagnostic tool across all Australian jurisdictions.

Here we present a roadmap for the implementation of HTS as a diagnostic tool in Australia with a focus on four themes:

- Policy: Generate guidelines and standards required for harmonising HTS usage, data analysis, reporting and data storage.
- Platforms: Establish the National Biosecurity Data Platform (NBDP) to bring together sequence information and metadata to allow the real-time analysis of disease outbreaks.

- Technical: Produce technical laboratory standards for generation and analysis of HTS outputs for diagnostics applicable to all platforms and biosecurity applications. Promote NATA accreditation for HTS diagnostics for jurisdictional biosecurity laboratories.
- Skills: Establish a national “Biosecurity Network for HTS” (BNHTS) to deliver training programs and workshops in bioinformatics and wet lab procedures, champion the use of HTS in state laboratories, promote Proficiency Testing activities, and support partner laboratories (twinning program) to improve HTS usage.

Mobile identification of biosecurity threats using image recognition

A N Schmidt-Lebuhn[1]

[1]CSIRO, Centre for Australian National Biodiversity Research, Canberra, ACT

alexander.s-l@csiro.au

Growing travel, transport, and trade increase biosecurity risks. Accurate and reliable species identification is critical for decision making at the border, reporting, and pathway analysis to guard against future threats. However, there is a limited number of taxonomic experts, and traditional identification and diagnostic tools are often difficult to access and require considerable training and background knowledge to use efficiently.

CSIRO's National Research Collections house millions of expertly identified specimens of insects, plants, and vertebrates that underpin research in biodiversity discovery, bioprospecting, environmental services, and biosecurity. These specimens are increasingly imaged, allowing them to be mobilised as a basis for research and the application development, including the use of computer vision in the identification of species.

In collaboration with Microsoft, we have prototyped a smartphone app for computer vision-based mobile identification and recording of biosecurity threats. It suggests identification estimates, displays species profiles and links to additional information, and allows the creation of observation records. After a first AI model was created for weed seeds, current collaborative projects are focusing on weeds (with CISS and NSW DPI) and pest insects (with DAWE).

The talk will discuss the history of the prototype development, outcomes of research projects building on it, and future directions and opportunities.

Biosecurity response is a risky business

W Schofield[1]

[1]ACT Biosecurity and Rural Services

Warren.schofield@act.gov.au

With the never-ending increase in people vehicle and freight movements the likelihood of biosecurity incursions into Australia and our local regions in high.

Although prevention is the best options the reality is that incursions do occur. How they are initially assessed and dealt with can make the difference between a minor incursion and a major catastrophe. Known pests or diseases generally have response strategies and actions in place, but what about the new ones? How do you assess the risk of a new unknown pest?

ACT Biosecurity has been trialling a method of assessing new biosecurity incursions that uses a risk-based methodology to suggest and or instigate the initial response. This utilises the PESTELO acronym to evaluate the risk posed by the incursion and provides a score to recommend what scale of response is required.

A group (4-5 people) consisting of technical experts, stakeholders and senior staff of the ACT Biosecurity team assemble to discuss the incursion and process the known information of the pest through the risk assessment tool to understand the impact both short and long term.

This approach has provided ACT Biosecurity responses to become more structured and consistent and sets the structure in place to escalate any response from “normal business” to an emergency response with an official Incident Management Team managing the response.

This risk-based approach ensures that there is a process that allows the agency time to stop and consider what is required for the specific biosecurity incursions and enables us to have structured biosecurity incursion responses opposed to panicked biosecurity incursion reactions.

Agvet chemical regulation in emergencies: APVMA's role in biosecurity responses

E Schutz[1], E Moore, L Macdonald

[1]Australian Pesticides and Veterinary Medicines Authority

enquiries@apvma.gov.au

Exotic pest incursions can be a daunting and costly situation for growers – especially when there are few control options available.

Timely availability of appropriate controls are a vital component of biosecurity responses. As the national regulator of agricultural and veterinary (agvet) chemicals, the Australian Pesticides and Veterinary Medicines Authority (APVMA) performs an essential role in ensuring access to safe and effective chemical control options for exotic disease and pest incursions. In emergency situations, stakeholders can use the APVMA permit system to gain access to chemicals for eradication and control of exotic pests.

This presentation will provide an overview of the APVMA and the agvet regulatory system, the role of the permit system in biosecurity responsiveness and preparedness, and how permit applications are evaluated. Attendees will gain insights into the process for legalising the use of pesticides in Australia and how to enhance their control measures for tackling exotic pests and diseases.

The APVMA permits team is here to support Australia's biosecurity responsiveness, and together we can improve the performance of our biosecurity system.

The invasive keyhole wasps: an aviation hazard.

P Shaw [1]

[1]Ecosure Pty Ltd

pshaw@ecosure.com

The keyhole wasp (Pachodynerus nasidens) is an invasive species from the Caribbean and Central and South America that has made its way to Australia. After several significant incidents involving aborted take-offs and aircraft returning under emergency conditions to Brisbane Airport, it was determined that this small wasp was responsible. The keyhole wasp was forming its mud nests in the pitot tubes of various jet aircraft and causing inaccurate airspeed indication to the pilots. Such incidents have in the past been blamed for crashes to large passenger aircraft; one incident in 1996 caused the death of 189 passengers and crew. Brisbane Airport partnered with Qantas to engage Ecosure to to determine the biological drivers of this species and to identify ways to manage the risk. In a first of its kind, this study established 3D printed replica pitot tubes of the sizes on the most common aircraft operating at the port. Probes were monitored for 39 months. Results indicated that peak nesting occurs in the summer months. Nesting success (as proportion of nests with live adult emergents) was optimal between 24 and 31°C and probes with apertures of more than 3 mm diameter are preferred. Not all areas on the airport are affected equally, with most nests constructed in one area. The proportion of grassed areas within 1000 m of probes was a significant predictor of nesting, and probe volume may determine the sex of emerging wasps. Modelling shows that simple management measures involving the placement of covers over probes can reduce risk to acceptable levels and the costs of not managing the problem far outweigh those of partial acceptance of risk. Climate modelling illustrates that several Australian airports would be threatened by the spread of the wasp. The study has been published in two peer reviewed journals.

Strategies upon strategies - bringing biosecurity RD&E together

M Sheehan[1], S Potter[1], R Price[2], A Pearce[3]

[1]Wild Matters, Castlemaine, VIC

[2]Centre for Invasive Species Solutions, Canberra, ACT

[3] Environmental Biosecurity Office, Department of Agriculture, Water and the Environment, Canberra, ACT

weedpriorities@wildmatters.com.au

Biosecurity research, development and extension (RD&E) is a complex policy space that encompasses a broad range of invasive organisms across many sectors. In addition to the numerous sector-based strategies are four over-arching national biosecurity strategies which cover animal health, plant health, marine pests and environment and community biosecurity. Each strategy acknowledges the interconnected nature of biosecurity RD&E and the need for better cross-strategy linkages, however the strategies have lacked a formal mechanism to achieve this and operate relative independently from one another. A stronger focus on identifying and progressing priorities of shared interest is widely recognised and would provide an opportunity to capitalise on the efficiencies of collectively addressing cross-industry priorities.

The National Environment and Community Biosecurity RD&E Strategy (NECBRDES) 2021-26, developed by the Centre for Invasive Species Solutions on behalf the Environment and Invasives Committee (EIC), was recently endorsed by the National Biosecurity Committee. The strategy aims to:

- better link biodiversity and biosecurity research and policy
- identify priorities and building and maintaining capability
- promote RD&E priorities for investment and
- work collaboratively across other national biosecurity RD&E strategies to identify shared priorities and opportunities.

Within a landscape of increasing risk and funding competition, the strategy presents an opportunity to strengthen linkages and focus efforts towards cross sector/strategy priorities. The strategy identifies actions to improve cross-strategy and cross-industry communication and connections in the short term through the appointment of a national coordinator. Part of this role will focus on working across the other national

biosecurity RD&E strategies to drive cross-strategy collaboration and implementation where opportunities exist.

NECBRDES 2021-26 and other recent initiatives such as establishing the Chief Environmental Biosecurity Officer and the Environmental Biosecurity Office, the formation of the EIC and the release of the National Biosecurity statement will work harmoniously to ensure equal weight is given to protection of environment and economy from biosecurity threats.

Biosecurity 2030

A Sheppard[1]

[1]Research Director Biosecurity, CSIRO Mission Office

To deliver on Commonwealth Biosecurity 2030 and support the National Biosecurity Strategy, CSIRO and the Department of Agriculture Water and Environment are co-developing a science Mission to support the transformational multidisciplinary innovation required to transform the National Biosecurity System by 2030. This presentation will outline the value proposition and the prospectus for this Mission, detailing proposed likely work packages as part of the partner engagement process across governments, industry and the NGO sectors.

Shortcomings in Companion animal biosecurity and disease surveillance.

S G Steele[1], J-A LML Toribio[1], S M Mor[2]

[1]University of Sydney, Sydney School of Veterinary Science, Camperdown, NSW

[2]University of Liverpool, Institute of Infection, Veterinary and Ecological Sciences, Merseyside L3 5RF, United Kingdom

sandra.steele@sydney.edu.au

Animal biosecurity in Australia is critical to maintaining our freedom from exotic pests and diseases. This ensures protection of agricultural export industries, our environment, native flora and fauna, tourism industries and lifestyle. Our biosecurity system comprises of national and state policies and strategies, including disease surveillance and outbreak management. Essential to this is the Emergency Animal Disease Response Agreement (EADRA), managed by Animal Health Australia, bringing together Australian, state and territory governments and livestock industry groups. However, companion animals are barely considered within these structures, with no companion animal groups being represented in EADRA and funding under the National Significant Disease Investigation Program being predominantly directed to livestock and wildlife in many state jurisdictions.

Our recent qualitative research identified significant concerns amongst veterinarians regarding the lack of formal structures and support to manage emergent and zoonotic diseases in companion animals. A study of Australian veterinary practitioners exploring constraints to investigation of atypical disease presentations found companion animal practitioners faced significant obstacles, even when concerned about the unknown potential for zoonotic spread in a sick animal. Constraints included costs of disease investigations due to reliance on client finances and difficulties accessing support from public veterinary services. Shortcomings in available equipment and protocols required for effective IPC and biosecurity within practices were also reported.

Interviews of clinical and non-clinical veterinarians regarding their responses during the COVID-19 pandemic also reflected these concerns. Early reports of transmission of COVID-19 from humans to pets were initially accompanied by uncertainty regarding the risk of ongoing transmission from animal sources, with a number of informants disturbed by the continuing lack of established governance structures for companion animals.

With increasing potential for emerging diseases, any vulnerabilities in animal biosecurity need to be addressed. Formation of structures alongside current animal health systems

specifically addressing companion animal diseases are required to optimize national biosecurity and mitigate human disease risk from emergent zoonoses.

Friendly fire: The pet trade of native species outside of their natural distributions in Australia

O C. Stringham[1,2], Stephanie Moncayo[1], Katherine G.W. Hill[1], Adam Toomes[1], Joshua V. Ross[2], Lewis Mitchell[2], Phillip Cassey[1]

[1]Invasion Science & Wildlife Ecology Lab, University of Adelaide, SA 5005, Australia

[2]School of Mathematical Sciences, University of Adelaide, SA 5005, Australia

oliverstringham@gmail.com

The trade of alien species as pets has long been recognised as a biosecurity risk. Accordingly, candidate alien pet animals undergo risk assessments to determine the safety of their trade in Australia. However, species native to Australia are often overlooked as biosecurity risks, even though they can be legally traded outside of their natural distributions. These 'interstate non-natives' may become invasive species, as evidenced by the establishment of the rainbow lorikeet (*Trichoglossus moluccanus*) in Western Australia and Tasmania, where the species does not naturally occur. Here, we investigated the trade of native Australian species outside of their natural distributions in Australia. We quantified the degree to which each species is traded within and outside of their distribution using e-commerce data collected from a popular online Australia classifieds website used to trade native pet birds, reptiles, and amphibians. Over a six-month period, we assessed c. 12k e-commerce advertisements and found 179 native species in the pet trade of which 140 species (78%) were traded outside of their natural distribution. On average, 60% of advertisements were outside of a species' native range. Our results indicate that the trade of native species outside of their natural distributions is widespread in Australia. Because many State/Territory laws do not consider 'native' Australian species a biosecurity risk, we suggest each state undergo risk assessments for species in the pet trade that are native to Australia but non-native to the State.

Online compliance and engagement strategy tackles prickly situation

D Swan [1], C Hollingdrake [1]

[1]Biosecurity Queensland

Duncan.Swan@daf.qld.gov.au

The illegal sale of invasive plants and trade of other biosecurity matter though online marketplaces such as eBay, Gumtree and Facebook, has skyrocketed in the last few years. Biosecurity Queensland have developed a new approach to target offenders through online marketplaces and tackle this issue head on.

We've expanded our traditional biosecurity compliance strategies to include surveillance and education of non-compliance in the online environment. These activities have resulted in over 2000 illegal cacti seizures from online sellers which would have otherwise gone undetected.

In 2017, we launched a compliance and education project targeting the illegal online sale of cacti. The project initially focused on online marketplaces including eBay and Gumtree, but has now expanded to include the biggest and most challenging platform, Facebook marketplace.

Using direct engagement, targeted advertising and 'story arcs' to build awareness and understanding of complex biosecurity issues, we have seen significant drop in the number of illegal cacti sales across online marketplaces.

This approach is now being expanded to address other biosecurity risk areas in Queensland including, the illegal movement of banana plants and fire ant carriers such as soil, turf and hay.

To support this new approach we have built the capability of our biosecurity officers in the use of online platforms, developed standard operating procedures for undertaking compliance work online, and established a working group with executive support to trial new approaches and share learnings.

Online sales are not going away. These platforms make it quicker, easier and cheaper to sell online and we must continually adapt and prepare for the next new platform.

Stepwise approach to genetic biocontrol of pest impacts: the case of the cane toad

M L Tizard[1] C A Cooper[1], M E Woodcock[1], R J Capon[2], T Strive[3],

[1] CSIRO Health and Biosecurity, Australian Animal Health Laboratory, Geelong, VIC, 3219, Australia.
[2] Division of Chemistry and Structural Biology, Institute for Molecular Bioscience, The University of Queensland , St Lucia, Queensland 4072, Australia
[3] CSIRO Health and Biosecurity, Black Mountain Laboratories, Canberra, ACT, Australia

Genetic biocontrol (a.k.a. gene drive) is on the agenda as a potentially powerful tool for the mitigation of invasive pest animal impacts, the landscape-scale degradation of native ecosystems. The animal itself becomes the delivery system, the control measure being amplified in through the population through sexual reproduction (hence "gene drive"). The mouse tops the list of pests for this approach and is a model species for the development of the necessary genetic tools. There are a number of challenges ahead, following technical considerations, including public acceptability, environmental and industry acceptability, political readiness and essential regulatory requirements. A case study demonstrating the real-world beneficial application of gene technology would be helpful. The cane toad is one of Australia's best-known invasive species, having devastated many tropical northern Australian ecosystems. It produces a lethal toxin (bufagenin) which is responsible for the deaths of countless predators, causing significant population declines in quolls, goannas, lizards, multiple species of snakes, freshwater crocodiles, and native amphibians. Our results demonstrate the ability to remove functional components of the gene responsible for synthesis of the lethal toxin. We have generated the world's first gene edited cane toads using CRISPR/Cas9, through a novel technology applicable to other aquatic species. Our focus is now on genes associated with the cane toad's incredible fecundity (females may lay clutches ≤ 30,000 eggs). Combining these two approaches could enable the release of cane toads (still distasteful but not lethal) into the wild to buffering growth of toad populations and helping predators to learn to avoid them as prey (and thus survive). The removal of a gene function in this way (CRISPR/Cas9), without the addition of new DNA, generates animals that recently amended Gene Technology Regulations do not classify as GMOs. Public surveys suggest high levels of potential acceptance of such an approach.

The need for a national integrated approach to wildlife trade surveillance and regulation

A Toomes[1], O C Stringham[1,2], S Moncayo[1], K G W Hill[1], J Maher[1], P Cassey[1]

[1]Invasion Science & Wildlife Ecology Lab, University of Adelaide, SA 5005, Australia

[2]School of Mathematical Sciences, University of Adelaide, SA 5005, Australia

adam.toomes@adelaide.edu.au

The international trade of live pets is an emergent source of invasive species through the pet-release pathway, yet the dynamics of this trade in Australia, including the frequency and diversity of alien animals traded, remain poorly characterised. In order to intercept invasive pets early in the trade-to-introduction pipeline, and thus develop a pre-emptive biosecurity approach, more stringent monitoring and regulation of the alien pet is required.

Wildlife trade is rapidly shifting from traditional brick-and-mortar marketplaces to centralised, large-scale e-commerce platforms that connect traders across multiple jurisdictions, often with conflicting trade legislation. Moreover, such platforms rarely scrutinise the legitimacy of the trade conducted, allowing knowingly or naively illicit trade to occur alongside legal activity, both of which may contribute to the spread of invasive species.

We adopted a semi-automated online trade surveillance methodology to (i) identify alien species being traded in Australia, (ii) quantify the proportion of trade that is illicit or unregulated, and (iii) highlight spatial and taxonomic biases in trade. A high diversity alien taxa are not permitted for live import yet are traded domestically within Australia. Such trade is not regulated by a consistent permit system, yet we found unregulated trade in species known to be of high biosecurity risk (e.g., Pyrrhura lepida).

While in the first instance our findings inform relevant government biosecurity agencies of present threats, our methodology also forms the basis for data sharing between researchers, biosecurity practitioners and both State/Territory and Commonwealth governments. We propose that our methodology can form the basis for real-time alerts of high-risk species and support improved enforcement of trade compliance. We also outline recommendations to improve synergy between Commonwealth and

State/Territory legislation pertaining to alien species import and trade, to address clear loopholes and minimise biosecurity threats.

The evolution of technologies in plant pest diagnostics – where we are now? What is on the horizon?

L Tran-Nguyen[1], Brendan C Rodoni[2, 3]

[1]Plant Health Australia, Canberra, ACT

[2]Agriculture Victoria, AgriBio, Bundoora, VIC

[3]School of Applied Systems Biology, La Trobe University

LTran-Nguyen@phau.com.au

Australia's biosecurity system is continually being challenged with an increasing number of exotic plant pests intercepted at the border and outbreaks occurring post border in recent years. Luckily, Australia is relatively isolated and with good and effective quarantine measures that keep exotic plant pests out of the country. However, interceptions still occur and sometimes, plant pests are detected post border, and thus triggers an incident response. Our export commodities increasingly require a health certificate to maintain market access. Why is it important? Plant industries make a significant contribution to Australia's agricultural production and exports. As at June 2020, around 377 million hectares was farmed by 87,800 crop and livestock businesses. In 2019–20, plant industries represented a gross value of $30 billion (including forest products, honey and beeswax) and plant exports were worth more than $25 billion, mainly grains, sugar, wine, forestry, cotton and horticultural products.

Contributing factors to biosecurity challenges include an increase in globalisation, growth in trade volumes, complex supply chains, export markets supported by evidence-based protocol and climate change and variabilities that can affect host and pest biology. To mitigate the rapidly changing risks, it is critical to have an improved and adaptable surveillance and diagnostic system to ensure exotic pests are found and eradicated early to avoid the establishment and spread and the resultant expensive eradication programs and to provide evidence of absence to maintain market access. Today, innovative diagnostic technologies such as high throughput sequencing (HTS) that are rapid, accurate, efficient and effective are used to support surveillance activities and early detection. However, this hasn't always been the case.

This paper will go back in time to the 20th century and summarise the evolution of plant pest diagnostics, the good, the bad and the not so pretty; what worked and what did

not work. Where we are now, and where innovation could take us into the future. The importance of resources, a capable and sustained workforce, gadgets, data, technology, infrastructure, research and adoption will be discussed.

Detection of exotic Khapra beetle environmental DNA using portable technologies in Australian biosecurity.

A Trujillo-González[1], D N Thuo[1], U K Divi[2], K Sparks[3], T Wallenius[3], D Gleeson[1]

[1]Institute for Applied Ecology, EcoDNA group, University of Canberra, 11 Kirinari Street, Canberra, ACT, 2617, Australia

[2]Biosecurity Strategy & Reform Division, Department of Agriculture, Water, and the Environment, GPO Box 858, Canberra, 2601, Australia

[3]Science and Surveillance Group, Biosecurity Plant Division, Department of Agriculture, Water and the Environment, GPO Box 858, Canberra, 2601, Australia

alejandro.trujillogonzalez@canberra.edu.au

Khapra beetle, *Trogoderma granarium* Everts, 1898, is a serious pest of stored grains and dried food products globally. In Australia, khapra beetle is considered the most important invertebrate pest for grains and a widespread incursion could cost the country $15.5 billion over 20 years. As part of their Biosecurity Innovation Program, the Australian Government Department of Agriculture, Water, and the Environment is exploring suitable molecular methods that complement Australia's biosecurity measures. Specifically, environmental DNA (eDNA) and RNA (eRNA)-based methods are being tested as non-invasive, sensitive detection tools using portable, point-of-care technologies to inform biosecurity officers on the presence of high-risk pests across the biosecurity continuum. This study tested laboratory-based and portable molecular technologies to detect khapra beetle environmental DNA/RNA collected during recent biosecurity responses to khapra beetle detections in Australia. We tested the use of vacuum cleaners to collect dirt samples at detection sites and multiple extraction protocols to isolate eDNA. We also tested two Real Time PCR TaqMan assays optimised for the detection of khapra beetle eDNA/RNA. We successfully collected, extracted, and amplified khapra beetle eDNA/RNA using laboratory and field-based Real Time PCR technologies and using both TaqMan assays. Field testing showed a high incidence of false positive detections and cross-contamination of samples mostly attributed to use of contaminated vacuum cleaners. Portable qPCR technologies reliably amplified khapra beetle DNA, showing an improved capacity to inform biosecurity officers on the identity of beetles in the field, however, further testing is required to assess assay reproducibility using portable technologies to detect eDNA. We discuss suitable methods to minimize sample cross-contamination, the potential of portable molecular technologies as viable tools for biosecurity officers in Australia, and the suitability of eDNA/RNA-based molecular detection methods to

complement global trade biosecurity for one of the most invasive and important grain pests worldwide.

Best practice guidelines for Australian/New Zealand eDNA biomonitoring programs

A Trujillo-González[1,2], De Brauwer[1,3]

[1] Southern eDNA Society

[2]Centre for Conservation Ecology and Genomics, EcoDNA group, University of Canberra, 11 Kirinari Street, Canberra, ACT, 2617, Australia

[3]Coasts and Ocean Research Group, The Commonwealth Scientific and Industrial Research Organisation – CSIRO, College Rd,Sandy Bay, TAS, 7005, Australia

alejandro.trujillogonzalez@canberra.edu.au

The rapid uptake of environmental DNA methods globally is an indication of its potential in environmental monitoring. In less than 15 years, the field of eDNA has matured well beyond the proof-of-concept state to current moves towards integration in research and monitoring projects globally. Australian and New Zealand researchers have played an important role in this eDNA revolution and as a region we continue to be at the leading edge of many new developments in the field. Despite this expertise, however, integration in official biomonitoring programs remains limited. There remains strong hesitancy with resource managers using eDNA because of the lack of a standardised biomonitoring workflow. National best practice guidelines are essential for the uptake of eDNA methods in government mandated biosecurity and ecosystem monitoring programs. On behalf of a cross-institutional group of >50 experts, we present the first AUS/NZ best practice eDNA guidelines for monitoring programs and eDNA assay validation protocols to invite feedback from the wider stakeholder community. Feedback will be incorporated in the guidelines prior to publication of the final document in June of 2022 and will shape how validated eDNA methodologies and assays would be integrated in Australian biomonitoring and biosecurity applications.

Holding back the tide: science-based tools for biosecurity risk management and incursion response

R D Van Klinken [1]

[1] CSIRO Health and Biosecurity, Dutton Park, Queensland

Rieks.Vanklinken@csiro.au

Biosecurity managers can draw on a wide range of measures to both help prevent and to respond to incursions. A key challenge when doing this is to assemble an appropriate mix of measures that stakeholders are confident will be effective and feasible but least onerous. Our research offers qualitative and quantitative tools to assist biosecurity managers to do just this. The tools include a framework to consider how management measures specifically reduce risk; a 'menu' of over 30 potential pest risk reduction measures that could be applied; and models to quantify the efficacy of individual measures and to assess the risk reduction outcome of combinations of measures. There is considerable benefit in having a shared set of language and tools, including when developing, assessing and communicating biosecurity risk management plans. We will demonstrate how these tools have been applied by regulators to refine Red Imported Fire Ant biosecurity protocols for the movement of nursery products from Queensland to New South Wales. We also explore how the use of multiple measures in a systematic approach to biosecurity risk management opens valuable opportunities to harness emerging technologies for surveillance, diagnostics, analysis, or compliance verification. In particular, we will outline a new project to investigate the application of optical scanning technology to detect infestations of pests of quarantine concern in fruit. This technology has the potential to offer improved accuracy, timeliness and cost-efficiency compared with visual inspection methods applied pre- or post-border.

Turing data into biosecurity intelligence: advancing solutions for data sharing, analytics and privacy protection

R D Van Klinken [1]

[1] CSIRO Health and Biosecurity, Dutton Park, Queensland

Rieks.Vanklinken@csiro.au

As data analytics and business intelligence tools continue to evolve, exciting opportunities are emerging to shift from reactive to proactive or preventative modes of management. This opens prospects for transformational change in the biosecurity and pest risk management fields. While the technologies for automating the capture and analysis of data from diverse sources are progressing, difficult challenges remain regarding data ownership, sharing, trust, governance and privacy. This panel of diverse experts will present and discuss needs, opportunities and potential solutions to drive progress towards biosecurity intelligence. The panel will include four speakers followed by a discussion forum, including questions and comments from symposium participants. The problem space and opportunities will be introduced by Rieks van Klinken. Panel members are to be confirmed, but are proposed to include:

- A CSIRO data privacy researcher who will present progress towards developing techniques for protecting privacy while enabling data for secondary purposes. Use of fruit fly surveillance data to generate insights for growers will be used as a case study.
- A leader from the DAWE to discuss prospects for developing data sharing, data analytics and business intelligence capabilities that enable export compliance records to support market access and improvement efforts as well as other biosecurity applications
- Industry perspective from a major horticultural import/export business
- A commercial perspective from a technology provider actively working in generating business intelligence from shared data whilst preserving privacy requirements.

Developing the National Established Weed Priorities framework

J Virtue[1], S Potter[1], H Cherry[2,3], M Sheehan[1]

[1]Wild Matters, Castlemaine, VIC

[2]NSW National Parks and Wildlife Service, Parramatta, NSW

[3]Weeds Working Group, Environment and Invasives Committee

weedpriorities@wildmatters.com.au

A draft National Established Weeds Priority (NEWP) Framework has been developed to direct national efforts for the future management of established weeds. The framework models an approach based on the refinement and expansion of one of Australia's largest stakeholder collaborations to reduce the spread and impacts of invasive plants, the Weeds of National Significance (WoNS) initiative. The WoNS initiative fostered partnerships at national, state/territory, regional and local levels, resulting in strategic on-ground control, containment and spread prevention programs; research into new and improved control techniques; and promotion of land holder awareness and uptake of best practice management.

The Australian Government is supporting the Environment and Invasives Committee's Weed Working group to extend past WoNS achievements to the NEWP framework, aligning with the existing national policy context. Extensive engagement continues with community, industry, conservation, indigenous, regional and government stakeholders across Australia to co-design the framework, with an aim of adopting an approach that collaboratively identifies and strategically addresses agreed future priorities for co-investment.

Whilst established weeds are typically perceived to be 'on the right-hand side' of the biosecurity invasion curve, this is often a matter of scale. At state/territory, regional and local levels there are many instances where prevention, eradication and containment of individual WoNS remains a wise investment. The revitalised approach to established weed management presented in the framework recognises that weed invasions are often multi-species, and hence focuses on common drivers of weed invasion and impact across Australia, rather than individual species.

This presentation will present the key components of the framework, including the future of WoNS, a new strategic concept – Weed Issues of National Significance (WINS) and a mechanism for addressing other national weed management actions, through a

National Established Weeds Action List. The results of the co-design process, including stakeholder input, will also be discussed.

Australia's biosecurity outlook – a plant health perspective

G Vivian-Smith[1]

[1]Department of Agriculture, Water and the Environment.

Australia is part of a complex, diverse and rapidly changing world and our biosecurity system must be ready to meet the challenges this brings. A number of threats to plant health are imminent and of high consequence, with several pest risk pathways expected to increase in importance. There are three risk areas of concern that challenge the system across all sectors and have the potential to be exacerbated by climate change. These are 1) the movement of pests and diseases into Australia from near neighbours to the north, 2) increased volume and complexity of global trade leading to the emergence of new pests and rapidly evolving global pest distribution patterns and dynamics, and 3) cargo contamination and hitch-hiker pathways.

A range of significant plant health threats, such as khapra beetle, fall armyworm, seed borne pathogens, brown marmorated stink bug, oriental fruit fly and Xylella are representative of the growing challenges these risk pathways present.

The Department of Agriculture, Water and the Environment is implementing a range of strategic actions within the remit of the Commonwealth to manage a growing risk profile by strengthening Australia's biosecurity system and its resilience. These actions are a part of the new Commonwealth Biosecurity Strategy 2030 that offers a clear and practical path forward. The goal is to protect Australia's agriculture, environment, economy and way of life, working together with key contributors and collaborators across governments, industry and other representative bodies, research organisations and individuals.

Investigating environmental DNA methods for the surveillance of introduced pest bees and Varroa mites

C Villacorta-Rath[1], A Trujillo-Gonzalez[2], C Goletsos[3], U Divi[4]

[1]Centre for Tropical Water and Aquatic Ecosystem Research (TropWATER), James Cook University, Townsville, QLD 4811, Australia

[2]EcoDNA Group, Institute for Applied Ecology, Faculty of Science and Technology, University of Canberra, Bruce, ACT, Australia

[3]Australian Chief Plant Protection Office, Department of Agriculture, Water and the Environment, Canberra, ACT, Australia

[4]Compliance Division - Risk & Innovation, Australian Government Department of Agriculture, Water and the Environment, Canberra, ACT, Australia

Cecilia.VillacortaRath@jcu.edu.au

Australia has one of the healthiest honeybee populations in the world, however, there continue to be threats from new pests and diseases. Recent incursions of Asian honeybees at the Townsville Port have carried in the Varroa mite. Estimates of A$21M – 50M pa are given for modelled economic costs avoided if the Varroa mite is kept out of Australia. Another species of biosecurity concern is the Dwarf honeybee, which can transmit a range of parasitic mites to European honeybees.

The Department of Agriculture and Fisheries, Queensland, recently had an Asian honeybee surveillance program to detect incursions in locations that are at risk of invasion. The program relied on collecting regurgitated pellets of rainbow bee-eaters at sentinel sites, which were then visually inspected for presence of Asian honeybee wings by expert entomologists. This method is laborious, and identification of Asian honeybee is contingent on recovering intact wings from the pellet. However, other body parts, such as legs and antennas cannot be used for

conventional bee identification. We are developing environmental DNA (eDNA) methods could revolutionize the way we survey for invasive bees and mites in bee-eater pellets. It would represent a time-efficient method, and could be more sensitive than visual pellet examination because eDNA analysis would allow detecting the species from body parts other than wings.

Researching detection thresholds of eDNA technology will allow determining its applicability for operational use in screening for priority species and diseases. Here we present the results of laboratory experiments showing how sensitive the eDNA technique is to presence of low levels of invasive bees and Varroa mites eDNA in bee-eater pellets. For example, eDNA methods detected single Asian and Dwarf honeybees in bee-eater pellets collected at sentinel sites. This demonstrates that eDNA surveillance is sensitive to the first arrival of introduced bees in novel locations.

Terrestrial invertebrate detection in water and soil using a targeted eDNA approach

C Villacorta-Rath[1], A Trujillo-González[2], **L Lach**[3], N Andrade-Rodriguez[1], D Burrows[1], D Gleeson[2]

[1]Centre for Tropical Water and Aquatic Ecosystem Research (TropWATER), James Cook University, Townsville, QLD 4811, Australia

[2]Institute for Applied Ecology, Centre for Conservation Ecology and Genomics, EcoDNA group, University of Canberra, 11 Kirinari Street, Canberra, ACT, 2617, Australia

[3]College of Science and Engineering, James Cook University, Cairns, QLD 4870, Australia

lori.lach@jcu.edu.au

Development of highly sensitive detection methods is a high priority for biosecurity. Effective detection methods enable early discovery of would-be invaders and can also provide confidence in eradication. Invasive ants are among the most harmful invasive species globally; they threaten the environment, human health and livelihoods, and social amenity, and Australia spends millions of dollars on control and eradication efforts. They can also be very challenging to detect. Targeted environmental DNA (eDNA) is increasingly being used as a highly sensitive tool for detecting small numbers of aquatic and marine organisms, but its usefulness as a detection method for terrestrial target species, such as ants, is relatively unexplored. We tested whether eDNA from the harmful and widespread yellow crazy ant (*Anoplolepis gracilipes*) could be detected from soil with yellow crazy ant traffic, from soil outside of putative yellow crazy ant nests, and from waterbodies adjacent to infestations. From soil, we detected the target species eDNA in 40–100% of field replicates across methods and sites. Water samples resulted in positive yellow crazy ant eDNA amplification (20–100% field replicates across sites), even at sites where ants had not been detected visually. Taken together, our results indicate that eDNA may be a useful method for detecting terrestrial invertebrates from soil and water. Additional research investigating the effect of environmental conditions on eDNA deposition and degradation in soil and water and factors that may lead to false negative results will be essential in determining the sensitivity and reliability of eDNA as a detection method relative to more conventional ant detection methods.

Taking a transdisciplinary approach to research for mitigating invasive alien species impacts in Western Australia

B L Webber[1,2]

[1]Western Australian Biodiversity Science Institute, Perth, Western Australia, Australia

[2]CSIRO Health & Biosecurity, Floreat, Western Australia, Australia

bruce.webber@wabsi.org.au

Understanding the most pressing challenges for research on managing invasive alien species can be transformed by including end-user input. However, better on ground outcomes equally require framing from research expertise when it comes to identifying the priorities for knowledge gaps that can be addressed by new research. We have taken a transdisciplinary approach to identifying state level priorities for research that will mitigate the threat to biodiversity from invasive alien species in Western Australia. We provide an overview of the framework taken to deliver a prioritised research program for feral cats and for weeds, and an insight into the most knowledge gaps identified by this process for both programs. Given that translation of research outputs into applied outcomes is frequently an impact bottleneck, we describe the delivery mechanisms that we have also deployed to ensure that research findings are applied by end users. We show how the Western Australian Feral Cat Working Group was formed to improve outcomes for biodiversity by better management of cats and operates under three key pillars: making existing information more accessible, prioritising future research, and coordinating effective management by all stakeholders. A similar steering committee oversees and facilitates delivery against the prioritised research program for weeds. Lastly, recognising that invasive alien species impacts are tenure blind, we show how these delivery mechanisms are designed to ensure improved collaboration and greater knowledge sharing amongst all stakeholders to improve biodiversity conservation outcomes by mitigating the threat of invasive alien species.

A simple and rapid detection of pests and pathogens at the borders using MinION sequencing

S Weerakoon Abeynayake[1], S Fiorito [1], A Dinsdale [1], M Whattam [1], K Sparks [2], R P Campbell [3], C Gambley [3].

[1]Plant Innovation Centre, Plant Import Operations, Biosecurity Plant Division, Department of Agriculture, Water and the Environment (DAWE)

[2]Operational Science and Surveillance, Science and Surveillance Group, Biosecurity Operations Division, DAWE

[3]Microbiology and Entomology, Biosciences, Queensland Department of Agriculture and Fisheries (QDAF)

shamila.abeynayake@agriculture.gov.au

The global spread of invasive pests and pathogens is expected to increase over the coming decades, requiring more effective surveillance tools for border diagnostics, pathway analysis and biosecurity compliance. Current diagnostic methods used at the border are mainly based on time consuming visual and microscopic examinations and requires significant experience and expertise. Here, we demonstrate a simple and rapid detection of pests and pathogens using Oxford Nanopore Technologies (ONT) MinION sequencing. The suitability of rapid sequencing of amplicons multiplexed after barcoding on Flongle flow cells were assessed by sequencing PCR amplified DNA barcodes from wide range of specimens including invertebrate pests, bacteria, virus, and viroids. This method allowed rapid sequencing (15 min sample preparation) of amplicons without the requirement of expensive and time consuming AMPure bead purification steps. After *de novo* assembly of sequencing reads using Geneious Prime bioinformatics software platform, the longest and the best quality contigs showed high percentage (> 97%) identity to the matching reference record in the National Centre for Biotechnology Information (NCBI) database. The identification of specimens using MinION sequencing was also confirmed by Sanger sequencing. Our results suggest that utilising MinION sequencing technology will enable better informed biosecurity decision making and provide a significantly faster and cost-effective alternative to existing Sanger sequencing molecular identification process. The method can be further improved by integration of isothermal recombinase polymerase amplification (RPA) and sequencing multiple barcode regions to use in operational settings

Reducing the Spread of Pests and Plant Pathogens via Smartphone-Enabled Quarantine Tags

D Willey[1]
[1]Fruitmentor, Inc.

dan@fruitmentor.com

Unintentional human movement of nursery trees outside of quarantined areas has the potential to spread both pests and plant pathogens. For example, in California there is a documented case of a homeowner moving a citrus tree with a quarantine tag attached out of a quarantined area in Southern California to Northern California. The homeowner spread Asian Citrus Psyllids to a new area without noticing the quarantine tag on the tree. The design of the quarantine tag affects human behavior and a good design has the potential to avoid the inadvertent spread of pests and plant pathogens by humans. Yet another problem is that quarantined areas can be complex and change over time. It can be difficult for a nursery customer to understand where a tree is allowed to be moved even if presented with an up-to-date quarantine map. To solve this problem, a new type of quarantine tag can be smartphone enabled via QR codes, enabling a customer in a nursery to easily see precisely where a tree is allowed to be moved via geolocation technology. Furthermore, once quarantine tags have been smartphone enabled, further improvements to the design of the quarantine tag are possible via deployment of different designs, collecting data on their usage, and performing a statistical analysis of the collected data. Developing smartphone-enabled quarantine tags and the associated software has a great potential to prepare Australia to more effectively deal with future incursions of pests and plant pathogens.