Global Biosecurity Conference 2010

safeguarding agriculture and the environment

28 February – 3 March 2010

Brisbane Convention and Exhibition Centre Queensland

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Contents

Welcome

On behalf of the conference organisers and sponsors, welcome to Australia's inaugural international biosecurity conference.

Global Biosecurity 2010: safeguarding agriculture and the environment is hosted by the Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease, the Cooperative Research Centre for National Plant Biosecurity and the Invasive Animals Cooperative Research Centre.

Opportunities for scientific exchange on biosecurity issues among researchers, government decision-makers, environmental agencies and industry have until now been limited. This event is an ideal opportunity to bring environmental and agricultural biosecurity to the centre stage.

Given recent developments on the Australian front — such as the implementation of recommendations from the national quarantine and biosecurity review — along with international issues such as food security and infectious disease transmission, the timing of the event is fitting.

We have a full program on offer, and over the next three days conference presenters will discuss drivers of biosecurity, threats and impacts, knowledge and biosecurity policy. There is no doubt that effective biosecurity measures are vital to keeping agricultural industries and the environment healthy, and enhancing market access for food and feed exports. The diversity of sponsors, exhibitors, presenters and delegates support the fact that biosecurity is everyones' business.

Global Biosecurity 2010: safeguarding agriculture and the environment could not happen without the help of many dedicated people and generous support from our sponsors. We thank everyone involved for their contribution to this inaugural event.

As well as progressing vital biosecurity issues and taking part in the networking opportunity our event brings, we hope you can find time to enjoy the surroundings and activities that Brisbane offers.

Again, we welcome you to the conference and look forward to seeing old friends and meeting new ones.

Dr Stephen Prowse
Chief Executive Officer
Australian Biosecurity CRC
for Emerging Infectious Disease

Dr Simon McKirdy
Chief Executive Officer
CRC for National Plant Biosecurity

Professor Tony Peacock
Chief Executive Officer
Invasive Animals CRC

Host Organisations

Conference Organising Committee

- Simon McKirdy, Chair – CRCNPB
- Stephen Prowse – ABCRC
- Tony Peacock – IACRC
- Kate Scott – CRCNPB
- Jim McGrath – PHA
- Alex Bagnara – IACRC

Conference Program Committee

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- Adriana Velez – ABCRC

Conference Sponsorship Committee

- Cain Roberts, Chair – CRCNPB
- Kate Scott – CRCNPB
- Jim McGrath – PHA

We thank the following people for reviewing abstracts and assisting with developing the program:

- Kirsty Bayliss – Murdoch University
- David Boyle – CSIRO Livestock Industry
- David Cook – CSIRO Entomology
- Dan Feiselmann – USDA APHIS
- Deborah Hailstones – Industry & Investment NSW
- Darryl Hardie – DAFWA
- Nigel Perkins – ABCRC
- Duncan Rowland – AHA
- Jo Slattery – PHA
- Sharyn Taylor – PHA
- Kyle Thoms – PHA
- Peter Whittle – QUT

Plenary Speakers

Listed in alphabetically order

Rebecca Bech

APHIS – United States Department of Agriculture

Rebecca Bech is the Deputy Administrator for Animal and Plant Health Inspection Service's (APHIS) Plant Protection and Quarantine (PPQ) program. Ms. Bech provides executive leadership and direction to a nationally dispersed staff responsible for safeguarding U.S. plant resources from destructive pests and diseases. She represents the USDA in international plant protection organizations and serves as the U.S. representative for the International Plant Protection Convention.

From April 2007 to January 2008, Ms. Bech served as the Deputy Administrator for APHIS' Biotechnology and Regulatory Services program. She joined APHIS in 1986, serving in numerous position including, a plant pathology identifier, branch chief for the National Identification Services, and the Director for Scientific Services. She led the National Invasive Species Initiative for the Department of Agriculture, serving as the USDA Liaison for Invasive Species, representing the Secretary's office.

Ms. Bech holds degrees in plant science and plant pathology and a Master's degree in education.

Angus Cameron

AusVet Animal Health Services

Angus Cameron is a veterinary epidemiologist with special interest in disease surveillance, freedom from disease, information systems and geographic information systems (GIS). He is director of AusVet Animal Health Services, a private epidemiology company. Angus shares his time between France and Australia, and is regularly involved in projects in Australia, Asia, Europe, North America and Africa

Mick Clout

Centre for Biodiversity & Biosecurity, University of Auckland

Mick Clout is a vertebrate ecologist. He has worked extensively on the ecology and behaviour of invasive mammals, and their impacts on native birds in New Zealand. Mick was the founding chair of the IUCN/SSC Invasive Species Specialist Group, which he led from 1993 to 2008. He is currently director of the Centre for Biodiversity and Biosecurity at the University of Auckland. He also chairs the NZ Biosecurity Impacts of Invasive Animals.

Rob Delane

Department of Agriculture and Food, Western Australia

Mr Rob Delane is the Director General for the Department of Agriculture and Food, Western Australia (DAFWA). Prior to this, Rob was the Executive Director of the Australian Quarantine and Inspection Service and Deputy Secretary of the Department of Agriculture, Fisheries and Forestry. Rob has also held the appointment of Deputy Director General (Biosecurity and Research) for DAFWA. His national roles include a directorship of Plant Health Australia and membership of the Quarantine and Exports Advisory Council. He has an MSc (Agric) and BSc (Agric) Hons from the University of Western Australia. Rob received a Public Service Medal in 2007 for outstanding public service to the agriculture industries and the community of Western Australia.

Robert L Griffin

Plant Epidemiology and Risk Analysis Laboratory, USDA-APHIS, Plant Protection and Quarantine, Center for Plant Health Science and Technology

Robert Griffin is the Director of the Plant Epidemiology and Risk Analysis Laboratory within the Center for Plant Health Science and Technology with USDA-APHIS. He has a MS degree in plant pathology and 34 years experience in plant quarantine. From 1997 to 2003, he worked for FAO as Coordinator for the International Plant Protection Convention (IPPC) with primary responsibility for the elaboration of international standards for phytosanitary measures, including the standards which currently form the foundation for pest risk analysis (PRA) used globally by the phytosanitary community.

Johann van der Merwe

Chevron Australia

Johann is an internationally recognised for protected area management, conservation planning, and biosecurity. He was the Director for South African National Parks, an organization entrusted with the management of some of the world's most vulnerable and irreplaceable biodiversity. He is also accredited with championing many of the first trans-boundary protected areas in Southern Africa and Southeast Asia. He has managed some of the world's largest invasive clearing programs in the catchments of high conservation value in South Africa. He was also responsible for the management of some of the world's most virulent veterinary diseases including anthrax, bovine tuberculosis, foot and mouth disease, feline aids, etc. Currently responsible for setting up a dedicated Quarantine Management System for the Gorgon Project.

Program

Sunday 28 February 2010

4.00pm – 7.00pm	Registration Desk Open Exhibition open
6.00pm – 7.30pm	Welcome Reception sponsored by Australian Quarantine and Inspection Service (AQIS) Room: Mezzanine M3

Monday 1 March 2010

8.45am – 9.00am	Official Opening Megan Clark, Chief Executive CSIRO Chair: Simon McKirdy Room: Mezzanine M4			
9.00am – 9.45am	Plenary 1: *Reshaping agricultural biosecurity for Australia* Rob Delane, Department of Agriculture and Food, Western Australia			
9.45am – 10.30am	Plenary 2: *Trade, Travel, Technology and Turmoil - The Drivers of Plant Biosecurity in the USA* Rebecca Bech, APHIS - United States Department of Agriculture			
10.30am – 11.00am	Morning Tea Room: Mezzanine M3			
Concurrent session 1	Threats	Drivers	Knowledge	Systems
	Chair: Sharyn Taylor Room: Mezzanine M1	Chair: Paul De Barro Room: Mezzanine M2	Chair: Martin Jeggo Room: Mezzanine M4	Chair: Room: Plaza P1
11.00am – 11.15am	The stripe rust pathogen of cereal crops in Australia: managing exotic and endemic threats to crop losses Colin Wellings	Comprehensive bioeconomic modelling of the risk management of multiple non-indigenous harmful species: to exclude, or to wait and control? Roman Carrasco	The Australian Biosecurity Intelligence Network – a Commonwealth funded infrastructure initiative Joanne Banyer, Bronwyn Morrish and Steve McMahon	The Tasmanian biosecurity system – a case study in biosecurity policy, strategy, and action Andrew Bishop

11.15am – 11.30 am	Characterisation of Indonesian H5N1 isolates to understand the prolonged infection and spread of H5N1 among domestic poultry Hendra Wibawa	Rethinking biosecurity policy interventions: use of network analysis David Newth	Improving biosecurity outcomes through networking Australia's Wildlife Health data with the Australian Biosecurity Intelligence Network Karrie Rose	Biosecurity and public health: two sides of the same coin? Mel Taylor
11.30am – 11.45am	Factors affecting the introduction, distribution, migration and colonisation of currant-lettuce aphid Nasonovia ribisnigri (Mosley) in Australia Craig Feutrill	Using an ecological-economic model to quantify and communicate bio-invasion uncertainty in deliberative multi-criteria evaluation Shuang Liu	Building a virtual microscopy laboratory network through the Australian Biosecurity Intelligence Network Marc Kabay	Managing wildlife biosecurity in Australia Lee Skerratt
11.45am – 12.00pm	Foxes and on-farm biosecurity: have they a role in bovine Neospora abortion? Jessica King	Decision making under uncertainty with application to biosecurity Rob Reeves	Remote microscopy: diagnostics, training and beyond Michael Thompson	Managing biosecurity across borders: a comprehensive strategy Ian Falk
12.00pm – 12.15pm	Australian plant susceptibility to Phytophthora ramorum and their role in driving a potential epiphytotic Kylie Ireland	A participatory approach to prioritizing plant pests and diseases David Cook	A biosecurity framework for harmonisation of knowledge Debra Riddell	Driving science into biosecurity policy and operations Barney Stephenson
12.15pm – 12.30pm	Bats and the emerging zoonotic disease threat Gary Crameri	If biological invasions are spatially and temporally explicit, why isn't biosecurity risk analysis? Brendan Murphy	Office of the Chief Veterinary Officer's (OCVO) scanning report: an approach to identifying emerging issues for animal health management in Australia Belinda Wright	Regulation - a necessary evil Merryn Pugh
12.30pm – 1.30pm	Lunch Room: Mezzanine M3			
Concurrent session 2	Threats	Drivers	Knowledge	Systems
	Chair: Room: Mezzanine M1	Chair: Room: Mezzanine M2	Chair: Peter Black Room: Mezzanine M4	Chair: Room: Plaza P1
1.30pm – 1.45pm	Red imported fire ants: the benefits of applied genetics to the eradication program Jane Oakey	Incorporating uncertainty into import risk assessments: a Bayesian melding approach Petra Kuhnert	Office of the Chief Veterinary Officer's (OCVO) animal health scanning activities: so far so good, where to from here? Belinda Wright	International biosecurity research across the quarantine continuum Andy Sheppard

1.45pm – 2.00pm	Are we prepared for an exotic disease outbreak in feral pigs? Steven Lapidge	Policy and legal framework for managing biosecurity (Indonesian Perspective) Theofransus Litaay	Biosecurity cyberinfrastructure for surveillance, modelling and risk analysis Roger Magarey	Biosecurity planning and implementation Sharyn Taylor
2.00pm – 2.15pm	Determining the natal origin of exotic pests using isotope and trace element geo–location markers Karen Armstrong	Australia's Government-Industry Partnership - a cornerstone of the biosecurity system Greg Fraser	Wildlife health information in Australia: bridging the gaps between wildlife and industry Rupert Woods	The National Goat Health statement, a tool to promote on-farm Biosecurity Lorna Citer
2.15pm – 2.30pm	Mobile mating disruption: using medflies against moths David Maxwell Suckling	The role of animal health laboratories in managing the risks from infectious diseases Martyn Jeggo	Building a global plant health alliance: the function and role of an integrated plant health information system Trevor Nicholls	Response management: one system to rule them all David Hayes
2.30pm – 2.45pm	Benefit–cost analysis of the long-term containment strategy for exotic fruit flies in Torres Strait Mary Ann Franco-Dixon	Biosecurity and developing world needs Perdeep Kumar	Grains biosecurity aligns with dynamic communication and adoption industry programs for on-farm impact Judy Bellati and Lisa Sherriff	An overview of the Emergency Plant Pest Response Deed (EPPRD) Rod Turner
2.45pm – 3.00pm	Siam weed (Chromolaena odorata): the true cost - beyond agricultural impacts to quantifying environmental impacts Sarah Goswami	The economics of biosecurity: import risk, border quarantine, local surveillance and eradication measures Tom Kompas	Grain knowledge networks and risk management for phosphine resistance in stored grain insects Anna Carr	Subcommittee on plant health diagnostic standards Barbara Hall
3.00pm – 3.30pm	Afternoon Tea Room: Mezzanine M3			
3.30pm – 4.15pm	Plenary 3: *Biodiversity impacts of invasive animal species* Mick Clout, University of Auckland Chair: Tony Peacock Room: Mezzanine M4			
4.15pm – 6.00pm	Poster Display Session sponsored by Springer Science + Business Media B.V			
6.00pm	'Sponsors and Exhibitors only' Thank you Cocktail Event – Rydges Southbank			

Tuesday 2 March 2010

8.45am – 9.00am	Housekeeping			
9.00am – 9.45am	Plenary 4: *Biosecurity issues for a large multi-national industry* Johan van Der Merwe, Chevron Chair: Trevor Nicholls Room: Mezzanine M4			
Concurrent Session 3	Threats	Drivers	Knowledge	Systems
	Chair: Johan van Der Merwe Room: Mezzanine M1	Chair: Room: Mezzanine M2	Chair: Room: Mezzanine M4	Chair: Gordon Gordh Room: Plaza P1
9.45am – 10.00am	Where and how much? Cost-effective surveillance for invasive species management Cindy Hauser	Principles of phytosanitary biosecurity surveillance Brendan Murphy	RabbitScan - engaging community knowledge Graeme Martin	Biosecurity surveillance problems are typically complex and require an integrated design approach: a solution Peter Whittle
10.00am – 10.15am	Multiple species detection: statistical aspects of surveillance design Susan Barrett	Are we on the right track to manage invasion pathways? Philip Hulme	Capacities needed to develop robust biosecurity organisations and policy Peter Black	Biosecurity surveillance design for invading species: updating expert estimates with experimental data Frith Jarrad
10.15am – 10.30am	Early detection, information gaps and the design of surveillance programs for invasive species Denys Yemshanov	The consequences of fire blight in Australian pome fruit industries David Cook	Biosecurity - the front line Chris Hawkins	PaDIL – innovation in delivering biosecurity to end users Ken Walker
10.30am – 11.00am	Morning Tea Launch of the National Plant Health Strategy sponsored by Plant Health Australia, with Dr Tony Gregson AM FTSE, Chairman of Plant Health Australia Room: Mezzanine M3			
Concurrent Session 4	Threats	Drivers	Knowledge	Systems
	Chair: Peter Whittle Room: Mezzanine M1	Chair: Hume Field Room: Mezzanine M2	Chair: Mick Clout Room: Mezzanine M4	Chair: Kareena Arthy Room: Plaza P1
11.00am – 11.15am	Landscape-scale surveillance of fungal plant pathogens undergoing aerial dispersal David Savage	A modelling framework for understanding the impacts of climate change on biosecurity incursions of cropping systems Hazel Parry	New technologies for disease surveillance Angus Cameron	Learning from experience: improvements to biosecurity responses in New Zealand Sarah Clinehens

11.15am – 11.30am	Future-proofing surveillance: the challenges of emerging viruses and host switching Deborah Middleton	An integrative approach to understanding the pest and disease threats to agricultural biosecurity under future climates Jo Luck	Point of truth calibration: putting science into scoring systems Simon Barry	Equine influenza eradication – lessons for future responses Ron Glanville
11.30am – 11.45am	Mission Path Planning (MPP) for an Unmanned Aerial System (UAS) fitted with an air sampling device Felipe Gonzalez	Effects of expansion in human activity and climate change on plant virus introductions and emergence Roger Jones	Harnessing expert knowledge for biosecurity Samantha Low-Choy	Biosecurity perceptions of horse owners and managers in New South Wales and their attitudes towards a potential future outbreak of equine influenza Kathrin Schemann
11.45am – 12.00pm	Modelling the proximal source of intercepted exotic insects Darren Kriticos	Impact of climate change on food security and biosecurity in small Pacific nations Angela Freeman and Pita Taufatofua	Evidence for absence from absence of evidence – quantifying the value of general surveillance Tony Martin	A smutty story - lessons from an incursion of sugarcane smut Barry Croft
12.00pm – 12.15pm	Contribution of general surveillance to demonstrating area freedom for grain pests Nichole Hammond	Assessing the risk of plant pathogens in the irrigation channels of the Ord River irrigation area Rebecca Zappia	How to deal with evidence uncertainty in biosecurity decision-making? Kim Lowell	Rabies on the move in Indonesia - lessons for Australia Helen Scott-Orr
12.15pm – 12.30pm	Toward practical, PCR-based detection methods for the surveillance of marine pests from ports and waterways Nathan Bott	Monitoring market infection status John Weaver	Preferences and priorities in risk mitigation across multiple values Terry Walshe	Risk factors for the spatial-temporaldistribution of Tabanus (Family: Tabanidae): a cart analysis Kirsty Moynihan
12.30pm – 1.30pm	Lunch Room: Mezzanine M3			
Concurrent session 5	Threats Chair: Jane Moran Room: Mezzanine M1	Drivers Chair: Room: Mezzanine M2	Knowledge Chair: Angus Cameron Room: Mezzanine M4	Systems Chair: Rod Turner Room: Plaza P1
1.30pm – 1.45pm	Full genome sequencing and its application in the identification of new biosecurity threats Simone Warner	Preventing and managing incursions of class 1 weeds in Queensland Michael Day	Finding the hole in the dyke: how to stop the spread of pests using aquatic weeds in Australia as a case study Byron Pakula	How can research inform policy in weed incursion management? Dane Panetta

1.45pm – 2.00pm	Using next-generation sequencing methods for diagnostics development: examples from phosphine resistance David Schlipalius	Pig producers' perceptions of the human swine influenza A (H1N1) outbreak and its effect on their biosecurity practices Navneet Dhand	New methods of providing statistical confidence in zero detections for surveillance programs – a case study in the eradication of Yellow Crazy Ants Bernie Dominiak	A way to weigh dread weeds - a policy framework to estimate the costs and benefits of commercially valuable invasive species Stephen Johnson
2.00pm – 2.15pm	Development and validation of molecular diagnostic protocols to support quarantine and certification programs for Australian horticulture industries Fiona Constable	Biosecurity practices of Australian horse owners one year after the 2007 outbreak of equine influenza Kathrin Schemann	Enhancing New Zealand's animal identification and tracing systems: experiences developing a system for tracking and tracing cattle and deer Christopher Houston	Australia's weeds of national significance program: achieving the biosecurity continuum Hillary Cherry
2.15pm – 2.30pm	Acaricide resistance in cattle ticks – current status, future trends and new technologies Louise Jackson	Public perceptions and conceptions of the human swine influenza A (H1N1) outbreak Navneet Dhand	Surveillance and capacity building for exotic plant pathogens in the Australian Cotton Industry Chris Anderson	Improving the integrity of exotic plant pest surveillance data with hand-held (PDA) Robert Emery
2.30pm – 2.45pm	Diagnostic tools to support quarantine pathology laboratories Linda Zheng	Village-level biosecurity for large ruminant transboundary disease risk management in northern Laos Peter Windsor	"Talking toads": community perceptions of the threat, impact and management of cane toads in northern Australia Anna Carr	Prospects for developing a mass-rearing facility for fruit fly parasitoids in Australia: an international viewpoint Olivia Reynolds
2.45pm – 3.00pm	Enhanced surveillance strategies for grapevine phylloxera Kevin Powell	Opportunity lost? Impacts of and responses to biosecurity breaches due to aquatic animal pathogens and their introduced hosts in Australia Richard Whittington	Biosecurity and taxonomic expertise Penelope Greenslade	Survival limits for Mediterranean fruit fly Francis De Lima
3.00pm – 3.30pm	Afternoon Tea Room: Mezzanine M3			
	Plenary 5: *Animal disease surveillance systems* Angus Cameron, AusVet Animal Health Services Chair: Stephen Prowse Room: Mezzanine M4			
4.15pm – 6.00pm	Poster Display Session sponsored by Springer Science + Business Media B.V			
7.00pm for 7.30pm	Conference Dinner sponsored by Queensland University of Technology (QUT) Room: Plaza Ballroom			

Wednesday 3 March 2010

8.45am – 9.00am	Housekeeping			
9.00am – 9.45am	Plenary 6: *Risk analysis to safeguard agriculture and natural biological systems* Robert Griffin, APHIS- United States Department of Agriculture Chair: Mark Burgman Room: Mezzanine M4			
Concurrent session 6	Threats	Drivers	Knowledge	Systems
	Chair: Simon Barry Room: Mezzanine M1	Chair: Petra Kuhnert Room: Mezzanine M2	Chair: Room: Mezzanine M4	Chair: Room: Plaza P1
9.45am – 10.00am	Forecasting spread for rapid response James Bennett	Hendra virus – disease ecology and emergence Hume Field	Biosecurity: wicked problems, wicked solutions Byron Pakula	Multidisciplinary design and flight testing of a remote sensing airborne biosensor Felipe Gonzalez
10.00am – 10.15am	Risky business: synthesising expert judgements for environmental risk assessments Petra Kuhnert	Grains post entry quarantine – threats, pathways and prevention Brendan Rodoni	Modelling the establishment and spread of Emergency Plant Pests (EPPs) in Australia: simulate or suffer Juan Jose Garcia Adeva	Trends in biosecurity risk assessment Mark Burgman
10.15am – 10.30am	Atypical BSE and atypical scrapie: a review of risks to human health, animal health and trade Reg Butler	Developing an ecological basis for managing the threat posed by phosphine resistant stored grain beetles in Australia Andrew Ridley	AUSFLU simulation modelling environment for pandemic influenza Sam Beckett	High-risk environmental 'solutions' involving invasive species Tim Low
10.30am – 11.00am	Morning Tea Room: Mezzanine M3			

Concurrent session 7	Threats	Drivers	Knowledge	Systems
	Chair: Terry Walshe Room: Mezzanine M1	Chair: Simon Firestone Room: Mezzanine M2	Chair: Richard Whittington Room: Mezzanine M4	Chair: Robert Griffin Room: Plaza P1
11.00am – 11.15am	Species traits associated with environmental and economic impact of plant pests Therese Pluess	Gaps in vertebrate pest biosecurity that need plugging Tony Peacock	DNA barcoding, an emerging global standard for species identification, could revolutionise biosecurity diagnostics Andrew Mitchell	Modelling biosecurity risks: more complexity or back to basics? David Jordan
11.15am – 11.30am	Assessing the robustness of risk maps and survey networks to knowledge gaps about new invasive pests Denys Yemshanov	Pathogens in vertebrate pests in Australia Wendy Henderson	Next-gen molecular readout systems for biosecurity Bronwyn Battersby	Improving the quality of qualitative risk assessments Mark Burgman
11.30am – 11.45am	Assessing spatial patterns of disease risk to biodiversity: implications for the management of the amphibian pathogen, Batrachochytrium dendrobatidis Kris Murray	Grapevine Phylloxera: genotypic diversity and implications for management of incursions Kevin Powell	Development of nationally endorsed diagnostic protocols for plant pests Barbara Hall	Reconciling quantitative and qualitative approaches to import risk assessment Simon Barry
11.45am – 12.00pm	Can we build better spatial temporal models of pest insect incursions? A trial using TOPS John Weiss	Building resilience into the sugarcane agroecosystem: preparing for Chilo Sacchariphagus in South Africa Stuart Rutherford	Guidelines for developing identification resources for plant protection and quarantine: accessibility, appropriateness, and circumscription Terrence Walters	Biologically inspired computing provides add-ons for pest risk assessment in Biosecurity Susan Worner
12.00pm – 12.15pm	Are scavenging ducks a biosecurity risk for HPAI spread and infection? Joanne Meers	Risk analysis for surra in Australia: some pieces of the puzzle Kirsty Moynihan	Categorisation of pests under the Emergency Plant Pest Response Deed (EPPRD) Sophie Peterson	Risk-return approach to biosecurity risk management: the role of the EpiCast model Don Gunasekera
12.15pm – 12.30pm	Risk analysis of virulent Newcastle disease associated with small landholders in Queensland, Australia Nina Kung	Emerging disease threats to protected cropping vegetable and ornamentals Len Tesoriero	Australia's EPP diagnostic database: the plant biosecurity toolbox Amy Carmichael	Pest risk prioritization using Deliberative Multi-Criteria Evaluation (DMCE): a case study Michael Hurley
12.30pm – 1.30pm	Lunch Room: Mezzanine M3			

Concurrent session 8	Threats	Drivers	Knowledge	Systems
	Chair: Mark Whattam Room: Mezzanine M1	Chair: Jo Luck Room: Mezzanine M2	Chair: Anna Carr Room: Mezzanine M4	Chair: Martin Barlass Room: Plaza P1
1.30pm – 1.45pm	Optimised sampling, processing and testing for enhanced detection and characterisation of Avian Influenza Virus from field samples Simone Warner	A proactive approach: risk assessment for the plant pathogen Xylella fastidiosa Anne Rathe	Strategies to Increase plant biosecurity capacity in Australia Kirsty Bayliss	Hierarchical Bayesian models: epidemiology and data for delimiting invasions Mark Stanaway
1.45pm – 2.00pm	Taking the guess work out of diagnostics: targeting the host with a new multiplex diagnostic platform Ximena Tolosa	Risk factors for the infection of horse premises by equine influenza in New South Wales Simon Firestone	Training the next generation of plant biosecurity professionals – the North Carolina experience Robert Griffin	Ecological simplification is bad for one('s) health: an Australian perspective Ro McFarlane
2.00pm – 2.15pm	Beyond ELISA: high throughput plant virus detection via multiplexed bead-based immunoassays Jill Meldrum	Relationships between H7 avian influenza isolates from the five poultry outbreaks (1976-1997) in Australia Dieter Bulach	Biosecurity education initiatives in the US Animal and Plant Health Inspection Service Jennifer Nicholson	Testing a self organising map in a virtual world of invasive species Dean Paini
2.15pm – 2.30pm	Can we use CSI methods to detect fungal spores on clothing? Dominie Wright	Reducing the impact of eradication for exotic grapevine pathogens Mark Sosnowski	Investigating plant pests just got fun! - plant biosecurity in school classrooms Kirsty Bayliss	Comparative assessment of the biosecurity risks associated with small and large scale pig producers Jenny-Ann Toribio
2.30pm – 2.45pm	Hyperspectral imagery for plant pest recognition Pattaraporn Khuwuthyakorn	Tall wheat grass and other invasive salinity 'solutions' Carol Booth	Issues and design challenges in building a biosecure live bird market in Hanoi John Weaver	Developing a paradigm for integrated insect eradication in orchard, urban and peri-urban areas Bill Woods
2.45pm – 3.00pm	Systematics of the Macropsinae (Hemiptera: Cicadellidae) leafhoppers of Australia Linda Semeraro	Trapping strategies for Mediterranean fruit fly in Australia Francis De Lima	Knowledge – the biosecurity commodity – summing up Stephen Prowse	Community engagement in biosecurity – success in six horticultural case studies Heleen Kruger
3.00pm	Closing Ceremony Room: Mezzanine M4			

Topics and times are correct at the time of publishing, however are subject to change.

Pre-Conference Meetings

'Attracting and Training the Next Generation of Biosecurity Professionals'

Venue: Brisbane Convention and Exhibition Centre

Time: Sunday 28 February 12.00pm to 5.30pm

The goal of this workshop is to share experiences and network with people interested in biosecurity education. The first part of the workshop is designated for informal presentations about current programs. Topics that may be covered include:

- Description of existing or planned programs
- Specific goals of education programs and target audience
- How to develop partnerships with universities or schools How to determine course content
- Resource needs
- Delivery methods
- Role of internships

The second half will be a discussion session to discuss future work and potential collaborations.

Social Program

Welcome Reception sponsored by

Australian Government
Australian Quarantine and Inspection Service

Date: Sunday 28 February 2010

Time: 6.00pm – 7.30pm

Venue: M3 – Mezzanine Level, Brisbane Convention and Exhibition Centre

Cost: Included in the full conference registration fees, $60 additional tickets for day delegates or partners

As a full delegate your conference name badge is your automatic entry to the Welcome Reception.

Conference Dinner sponsored by

QUT

Date: Tuesday 2 March 2010

Time: 7.00pm for 7.30pm start

Venue: Plaza Ballroom, Plaza Level, Brisbane Convention and Exhibition Centre

Cost: Included in the full conference registration fees, $140 additional tickets for day delegates or partners

You will need to show you pre-purchased ticket at the door for entry to the conference dinner.

Delegate Information

Brisbane – the host city

Brisbane is the capital city of Queensland with a wide range of landscapes and lifestyles to enjoy. The inner city is surrounded by leafy suburbs and boasts the City Botanic Gardens and the Brisbane River. Fortitude Valley's cafes and boutique shops are a must and for an adrenalin-pumping view of the city and its surrounds, you can do a bridge climb, abseil down Kangaroo Point Cliffs or coast over in a hot air balloon. Nearby Moreton Bay and its islands provide water sports, sailing and fishing. You can even feed the wild dolphins and toboggan down the world's tallest sand dunes. Summer in Brisbane is truly glorious. You can expect sub-tropical weather with hot days and mild nights. The average temperature in February is 21 – 29 degrees Celsius.

Conference Venue – Brisbane Convention and Exhibition Centre

The Brisbane Convention and Exhibition Centre, Brisbane's state of the art purpose built conference and exhibition venue, is located in the unique South Bank riverside precinct, the city's cultural and entertainment hub. Set in lush subtropical riverfront parkland, it is within walking distance of the dynamic urban lifestyle and retail precinct with more than 30 restaurants, cafes and bars, stylish shops, symphony orchestras, state opera companies and performing arts theatres that showcase Queensland's art and culture.

Dietary Requirements

The venue has been notified of delegates' special dietary requirements previously advised to Conference Solutions upon registration. Delegates with pre-ordered special meals should make themselves known to venue staff, as it will not be possible for staff to locate you personally.

Internet Access

There is limited free wireless internet access available for conference delegates throughout the centre. If you wish to have access to the internet, a log-in and password are available from the registration desk. Please be advised that the internet access has been arranged as a courtesy to delegates. To ensure all conference delegates have accessibility to this service, we ask that you limit your time to a maximum of ten minutes at a time. If you require longer access you can purchase more at the Convention Centre Reception desk.

Messages

A message board is located adjacent to the Registration Desk. No responsibility will be taken to deliver messages personally unless they are of an urgent nature. Callers may leave messages with registration staff by telephoning the contact number listed.

Mobile Telephones

As a courtesy to speakers and fellow delegates please ensure that your mobile telephone is turned off or placed on mute during conference sessions.

Name Badges

Name badges must be worn at all times. They are your official pass to the conference sessions and refreshment breaks. Delegates without a name badge will not be permitted to enter sessions or the Exhibition area.

Registration and Information Desk

The registration desk for the Global Biosecurity Conference is located on the Mezzanine Level of the Brisbane Convention and Exhibition Centre. The desk will be open during the following times:

Sunday 28 February 4.00pm – 7.30pm

Monday 01 March 8.00am – 5.00pm

Tuesday 02 March 8.00am – 5.00pm

Wednesday 03 March 8.00am – 4.00pm

Registration desk staff are happy to assist you with any queries you may have.

The phone number for the registration desk is 0412 484 551.

Shopping

The closest shopping precinct is the Queen St Mall which trade seven days a week.

Speaker's Preparation Room

The speaker's preparation room is located in room M10 on the mezzanine level of the Brisbane Convention and Exhibition Centre. Staff at the registration desk will be happy to guide speakers in the right directiovn.

Taxis

Black and White Taxis: 133 222

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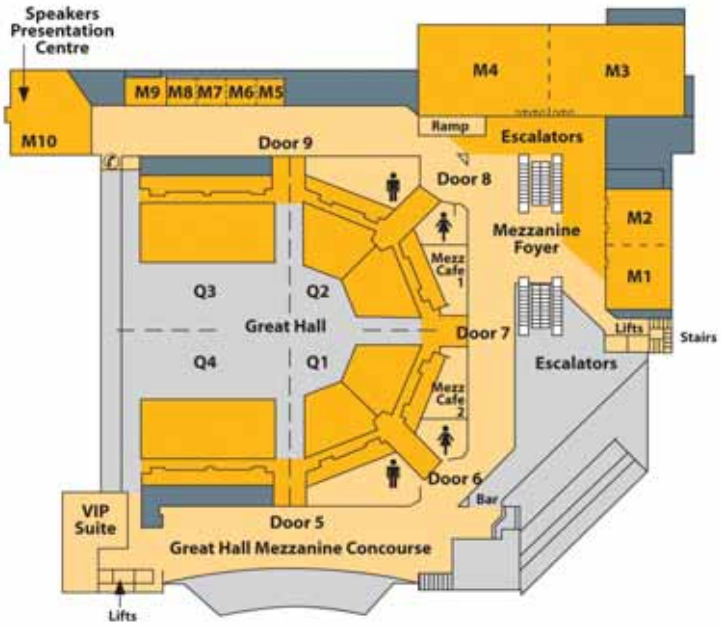
Conference Solutions
As agent for
Global Biosecurity 2010
PO Box 238
Deakin West ACT 2600

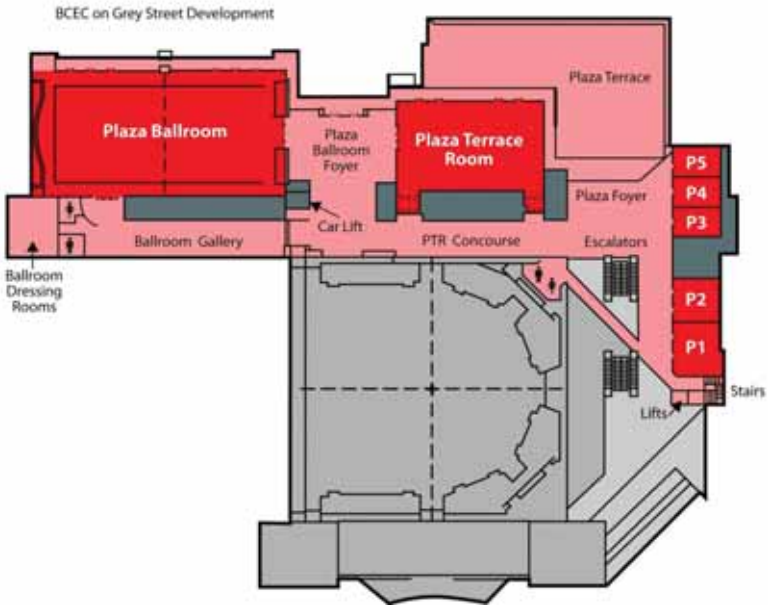
Tel: 61 2 6285 3000
Fax: 61 2 6285 3001
Email: biosecurity@con-sol.com

Venue Map

Brisbane Convention and Exhibition Centre – Mezzanine Level



Brisbane Convention and Exhibition Centre – Plaza Level



Plenary Sessions – M4

Concurrent Sessions – M1, M2, M4, P1

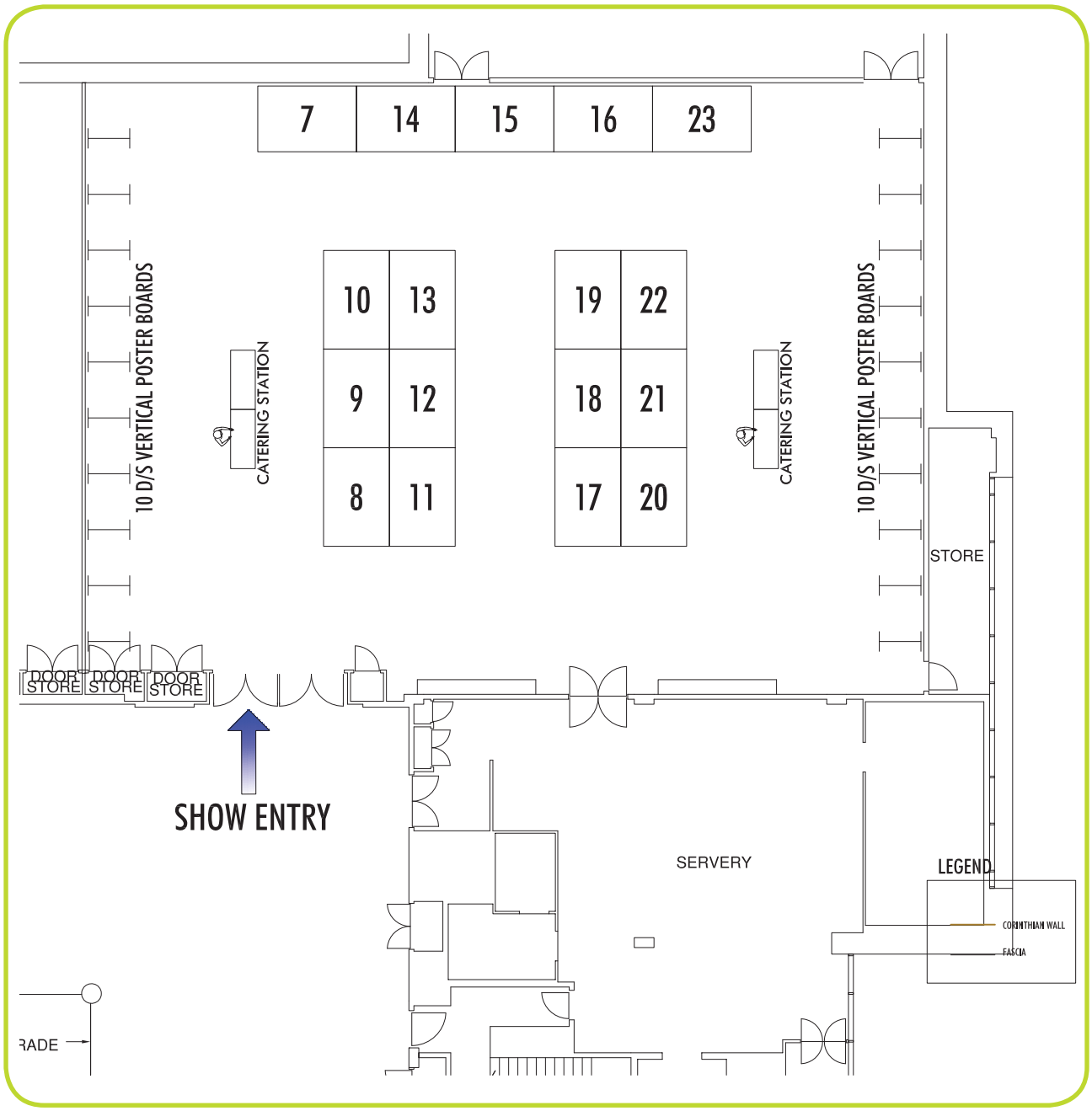
Exhibition – M3

Speakers Preparation Room – M10

Welcome Reception – M3

Conference Dinner – Plaza Ballroom

Exhibitors Floor Plan



Exhibitor Listing

Booth #	Organisation
8	Cooperative Research Centre for National Plant Biosecurity
9	Queensland University of Technology
10	Invasive Animals Cooperative Research Centre
11	Digital Diagnostics & Dino-Lite
12 & 13	Farm Biosecurity, Plant Health Australia and Animal Health Australia.
14	Australian Quarantine and Inspection Service
15	Springer Science + Business Media B.V
16	Australian Biosecurity Intelligence Network
17	Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease
18	CABI
19	EcoGene
20	Biosecurity Queensland
22	Weeds of National Significance

Sponsors and Exhibitors Listings

Platinum and Satchel Sponsor

Company Name: Horticulture Australia Limited
Contact Name: Karen Symes
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Telephone: 02 8295 2300
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Website: www.horticulture.com.au

Horticulture Australia Limited (HAL) is a not-for-profit, industry-owned company. It works in partnership with Australia's horticultural industries to invest in research, development and marketing programs that provide benefit to industry and the wider community. HAL invests almost $90 million annually.

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Company Name: GRDC
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Website: www.grdc.com.au

* company profile not available at time of print

Silver Sponsor

Company Name: ACERA
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Email: cwatts@unimelb.edu.au
Website: www.acera.unimelb.edu.au

ACERA (Australian Centre of Excellence for Risk Analysis) is contributing to national and international progress in biosecurity risk analysis methodology. Research themes have centred on biosecurity framework development; qualitative and quantitative risk analysis methods; surveillance and monitoring; and, communication and decision making. For information see our website at www.acera.unimelb.edu.au

Conference Dinner Sponsor and Booth 09

Company Name: Queensland University of Technology (QUT)
Contact Name: Professor Ian Mackinnon
Position: Professor of Research and Commercialisation
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Email: ian.mackinnon@qut.edu.au
Website: www.qut.edu.au/research

QUT is a successful university and has one of Australian's fastest growing research profiles. With an applied emphasis in teaching and research our aim is to produce outcomes that make a real difference to the world around us. Our research is characterised by quality, relevance, partnerships and a multidisciplinary approach.

Welcome Reception Sponsor and Booth 14

Company Name: AQIS
Contact Name: Jenet Connell
Position: Executive Manager
Address: GPO Box 858
Canberra ACT 2600
Telephone: 02 6272 5990
Fax: 02 6272 5594
Email: jenet.connell@aqis.gov.au
Website: http://www.daff.gov.au/aqis

AQIS, the Australian Quarantine and Inspection Service, is part of the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF). AQIS manages quarantine controls at Australia's borders to minimise the risk of exotic pests and diseases entering the country. It also provides import and export inspection and certification to help retain Australia's highly favourable animal, plant and human health status and wide access to overseas export markets.

As part of reforms following the 2008 review of Australia's quarantine and biosecurity services, AQIS became part of the larger Biosecurity Services Group in DAFF that encompasses pre-border, border and post-border functions on behalf of the Australian Government.

Poster Display Sponsor and Booth 15

Company Name: Springer Science + Business Media B.V
Contact Name: Zuzana Bernhart
Position: Senior Publishing Editor | Plant Pathology & Entomology
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3311 GX Dordrecht
The Netherlands
Telephone: +31 78 657 6129
Fax: +31 78 657 6388
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Website: www.springer.com www.springerlink.com

Springer is a major publisher of books and journals in life sciences. Please stop by our booth to order books at a special conference discount and take a closer look at sample issues of journals. Staff will be on hand to answer any questions you might have about publishing with Springer.

Tuesday Morning Tea Sponsor

Company Name Plant Health Australia
Contact Name: Jim McGrath
Position: Communications Manager
Address: c/o Plant Health Australia
Suite 5, 4 Phipps Close
Deakin ACT 2600
Telephone: 02 6215 7708
Fax: 02 6260 4321
Email: jmcgrath@phau.com.au
Website: www.farmbiosecurity.com.au

Plant Health Australia (PHA) is the lead national coordinating body for plant health in Australia. We are a not-for-profit organisation that works in partnership with industry, governments, researchers and others to facilitate improvements in policy, practice and performance of Australia's plant biosecurity system and to build capability to respond to plant pest emergencies. Our efforts enhance Australia's plant health status, assist trade, and safeguard the sustainability and profitability of our plant industries.

PHA Members include the Australian Government, all state and territory governments, national plant industry representative bodies and related industry partner organisations.

Booth 08

Company Name: CRC for National Plant Biosecurity
Contact Name: Kate Scott
Position: Communications Manager
Address: LPO Box 5012
Bruce ACT 2617
Telephone: 0402 299 611
Email: k.scott@crcplantbiosecurity.com.au
Website: www.crcplantbiosecurity.com.au

The Cooperative Research Centre for National Plant Biosecurity coordinates plant biosecurity scientific research throughout Australia. Our research programs cover the full biosecurity continuum; pre-border, border and post-border demonstrating our commitment to safeguarding Australia's plant industries. We also provide education and training in plant biosecurity through various activities. We have an extensive collaborative network of researchers and educators from 23 participating organisations representing industry, universities, state and federal government.

Booth 10

Company Name: Invasive Animals Cooperative Research Centre
Contact Name: Professor Tony Peacock
Position: Chief Executive Officer
Address: Building 3, Level D, Room 1
University of Canberra ACT 2601
Telephone: 02 6201 2887
Fax: 02 6201 2532
Email: contact@invasiveanimals.com
Website: www.invasiveanimals.com / www.feral.org.au

The IA CRC and our 41 partners work together to reduce the impacts of invasive animals, which cost Australia over $750 million each year. We aim to develop practical, cost-effective and socially-acceptable products and strategies, helping agricultural industries and Australian landscapes, and saving native animals and plants from extinction.

acera
Australian Centre of Excellence for Risk Analysis

Booth 11

Company Name: Digital Diagnostics
Contact Name: Dr Gary Kong
Position: Project Leader
Address: LPO Box 5012
Bruce ACT 2617
Telephone: 0423 024 118
Fax: 02 6201 5067
Email: g.kong@crcplantbiosecurity.com.au
Website: www.padil.gov.au/pbt www.biosecuritybank.com

New digital technologies will provide the building blocks of future diagnostic information systems. The Plant Biosecurity Toolbox™ and the Biosecurity Bank are web-based tools which provide users with specific diagnostic information to help them identify exotic plant pests. In addition, a Remote Microscope Network will allow experts to view and identify specimens in real time via a microscope and internet connection.

Company Name: SciNet
Contact Name: Stephen Wilkinson
Position: Director
Address: Unit 3, 39 Winton Road
Joondalup WA 6027
Telephone: 08 9301 1100
Fax: 08 9301 1300
Email: steve@scinet.com.au
Website: www.scinet.com.au

SciNet is based in Joondalup, Western Australia and is the Australian distributor for AnMo Electronics, the manufacturer of the Dino-Lite digital handheld microscope and microscope camera eyepieces. Dino-Lite digital microscopes and camera`s can be purchased via dealers nationwide.

Booths 12 & 13

Company Name: Farm Biosecurity
Contact Name: Jim McGrath
Position: Communications Manager
Address: c/o Plant Health Australia
Suite 5, 4 Phipps Close
Deakin ACT 2600
Telephone: 02 6215 7708
Fax: 02 6260 4321
Email: jmcgrath@phau.com.au
Website: www.farmbiosecurity.com.au

Farm Biosecurity is a national campaign and website that helps producers reduce the risks of exotic pests and diseases. It provides information to identify and minimise risks to farm production through simple farm management practices. Farm Biosecurity is a joint initiative of Animal Health Australia and Plant Health Australia.

Animal Health Australia (AHA) is an innovative partnership involving the Australian Government, state and territory governments, major livestock industries and other stakeholders. The company works with members and stakeholders to strengthen Australia's national animal health system and maximise confidence in the safety and quality of Australia's livestock products in domestic and overseas markets. Within the framework of a not-for-profit company, AHA manages more than 50 national programs that improve animal and human health, biosecurity, market access, livestock welfare, productivity and food safety and quality.

Booth 16

Company Name: Australian Biosecurity Intelligence Network
Contact Name: Andrew Chapman
Position: Corporate Officer
Address: GPO Box 664
Canberra ACT 2601
Telephone: 0400 025 590
Email: achapman@abin.org.au
Website: www.abin.org.au

Established by National Collaborative Research Infrastructure Committee (NCRIS) funding, ABIN was created to offer 'real time' access to data, information and use of leading edge tools and technologies to generate intelligence that will dramatically improve the ability of the biosecurity community of researchers, industry and governments to work together.

Booth 17

Company Name: Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease
Contact Name: Dr Stephen Prowse
Position: Chief Executive Officer
Address: Building 76 Molecular Biosciences
The University of Queensland
St Lucia QLD 4072
Telephone: +61 (0)7 3346 8861
Fax: +61 (0)7 3346 8862
Email: info@abcrc.org.au
Website: www.abcrc.org.au

We have developed new capabilities to detect, identify, monitor, assess, predict and respond to emerging infectious disease threats which impact on national and regional biosecurity. Research outcomes include new systems to detect pathogens, improved understanding of the ecology of emerging infectious diseases, epidemiological tools and syndrome surveillance systems.

Booth 18

Company Name: CABI
Contact Name: Chris Edmeades
Position: Regional Sales Manager
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WALLINGFORD
Oxfordshire UK 0X108DE
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Fax: +61(0)2 9712 7842
Email: c.edmeades@cabi.org
Website: www.cabi.org

CABI is a not-for-profit science-based development and information organization. We improve people's lives by providing information and applying scientific expertise to solve problems in agriculture and the environment. CABI helps address the challenges of food security by helping farmers grow more and lose less.

Booth 19

Company Name: EcoGeneTM
Contact Name: Dr Frank Molinia
Position: Facility Manager
Address: Private Bag 92170
Auckland New Zealand 1142
Telephone: +649 574 4225
Fax: +649 574 4101
Email: moliniaf@landcareresearch.co.nz or
ecogene@landcareresearch.co.nz
Website: www.ecogene.co.nz

EcoGeneTM is a Landcare Research business aiming to be Australasia's leading provider of DNA-based services for biosecurity and biodiversity. From its Auckland laboratory we provide cost-effective and fast turnaround service for species identification, vertebrate pest monitoring, genotyping and disease screening and our suite of diagnostics is expanding all the time.

Booth 20

Company Name: Biosecurity Queensland (Department of Employment, Economic Development and Innovation)
Contact Name Karl Sismey
Position: Project Officer
Address: Level 3, 80 Ann Street
Brisbane QLD 4000
Telephone: 13 25 23 (interstate)
+61 7 3404 6999 (overseas callers)
Email: callweb@dpi.qld.gov.au
Website: www.deedi.qld.gov.au

Queensland is a frontline state for biosecurity in Australia, mounting more major responses than any other state. Queensland's geography as well as global changes means this trend is likely to continue.

Biosecurity Queensland provides strategic direction to protect Queensland's economy, environment and social amenity from the risks and impacts of pests and diseases.

Booth 22

Company Name: Weeds of National Significance
Address: C/ John Thorp Australia
PO Box 96
Newstead TAS 7250
Telephone: 03 6344 9657
Email: jthorp@jta.com.au
Website: www.weeds.org.au/natsig.htm

The Weeds of National Significance (WoNS) program coordinates the national effort against 20 of Australia's worst invasive plants and facilitates consistent national actions to reduce impacts and prevent further spread of these weeds. Program partners include the Australian Government, States and Territories, regional bodies, industry, land managers and community groups.

Plant Health AUSTRALIA

INVITATION

NATIONAL PLANT HEALTH STATUS REPORT 2008-2009

Join us for the launch of the National Plant Health Status Report, an essential reference for anyone with a stake in Australian plant industries, including producers, traders, regulators, researchers, policy makers and educators. This second edition has been fully revised and updated, providing a comprehensive overview of Australia's plant biosecurity system.

Morning Tea, 10:30am
Tuesday 2 March 2010
Exhibition Hall, Brisbane Convention Centre

The National Plant Health Status Report has been compiled by Plant Health Australia (PHA) with contributions and input from Australia's key plant biosecurity stakeholders.

PHA is the lead national coordinating body for plant health in Australia, working in partnership to enhance Australia's plant health status, assist trade, and safeguard the sustainability and profitability of our plant industries.

Advancing Australia's biosecurity education and training

GEN-10-1198 CRCOS no. 00213J

QUT has an established national and international reputation in plant biosecurity and is leading the development of a national postgraduate curriculum.

Postgraduate research opportunities are currently available in key areas of expertise including:

- quantitative biosecurity
- risk analysis
- modelling
- surveillance systems
- entomology
- vertebrate pests
- weeds
- environmental impact
- invasion biology
- market access
- systems approaches

More information

For further information about PhD projects and scholarships available through QUT's Faculty of Science and Technology, contact Associate Professor Tony Clarke on 07 3138 5023, email a.clarke@qut.edu.au or visit www.qut.edu.au/research.

Plant Biosecurity Program

www.plantbiosecurity.edu.au

a university for the **real** world®

QUT

Building Australia's expertise in biosecurity

GEN-10-1197 CRCOS no. 00213J

QUT has an established national and international reputation in plant biosecurity.

Through the Cooperative Research Centre for National Plant Biosecurity, QUT is providing real-world solutions to the challenges of ensuring food security and safeguarding Australia's plant industries.

Key areas of expertise include:

- quantitative biosecurity
- risk analysis
- modelling
- surveillance systems
- entomology
- vertebrate pests
- weeds
- environmental impact
- invasion biology
- market access
- systems approaches

QUT's ongoing involvement in practical initiatives, including the Pest and Diseases Image Library and the Plant Biosecurity Toolbox, is making a valuable contribution to web-based diagnostic information for the rapid identification of exotic plant pests and diseases.

Collaborative research opportunities in plant biosecurity are available through QUT's Faculty of Science and Technology. Research opportunities in plant sciences are also available through the QUT Institute for Sustainable Resources and the QUT Centre for Tropical Crops and Biocommodities.

More information

Contact Associate Professor Tony Clarke on 07 3138 5023, email a.clarke@qut.edu.au or visit www.qut.edu.au/research.

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QUT




HAL

Know-how for Horticulture™

Horticulture Australia Limited (HAL)

is a not-for-profit company that invests in research, development and marketing programs to provide benefit to horticultural industries and the wider community. HAL is owned by the peak industry bodies of 37 Australian horticultural industries covering fruits, vegetables, nuts, amenity and extractive crops.

As part of the Federal Government's commitment to rural research and development, horticultural industries can access matching Commonwealth funding through HAL for research and development activities.

HAL invests around $73 million of industry levies, voluntary contributions and matched Federal Government funds annually in R&D programs designed to align with the strategic investment priorities of Australia's horticultural industries and the Federal Government's Rural Research and Development priorities. An additional $12 million of industry levies is invested annually in strategic marketing programs.

To find out more about HAL and how programs are funded please visit

www.horticulture.com.au





Plenary Speakers Abstracts

(in presentation order)

Reshaping agriculture biosecurity for Australia

Rob Delane, *Department of Agriculture and Food, Western Australia*

Australia has an enviable pest and disease status which provides significant benefit to the Australian industry, environment and community. However as new challenges arise and the global situation changes, biosecurity systems must evolve and improve to maintain their effectiveness.

The recent review of Australia's quarantine and biosecurity arrangements (the Beale Review) recommended a new paradigm shifting from over-emphasis on border activities to strengthening systems along the biosecurity continuum (pre-border, border and post-border). This involves targeted, risk-based implementation of controls and sharing responsibility for biosecurity between governments, industry and the community. The new paradigm recognises that zero-risk is unachievable and encourages biosecurity stakeholders to work "smarter", particularly through risk-based targeting of resources to areas of the biosecurity system where activities will have the greatest return for the resources invested.

Reshaping of Australia's agriculture biosecurity will not be solely based on the outcomes of the Beale Review. There are many other challenges facing Australia: many biosecurity budgets are shrinking as a result of the global financial crisis and competing priorities; long term drought affects the ability of the agricultural community to invest time and money in biosecurity; there is a growing expectation that biosecurity arrangements will cover threats that impact beyond primary production; and, there is ever-increasing pressure for market access, both into and out of Australia.

It is within this context that biosecurity agencies in Australia are working to enhance our biosecurity system. Partnerships and associated decision making processes are being strengthened to protect the biosecurity status of our agricultural industries, together with the environment, is secured for future generations.

Biography: Mr Rob Delane is the Director General for the Department of Agriculture and Food, Western Australia (DAFWA). Prior to this, Rob was the Executive Director of the Australian Quarantine and Inspection Service and Deputy Secretary of the Department of Agriculture, Fisheries and Forestry. Rob has also held the appointment of Deputy Director General (Biosecurity and Research) for DAFWA. His national roles include a directorship of Plant Health Australia and membership of the Quarantine and Exports Advisory Council. He has an MSc (Agric) and BSc (Agric) Hons from the University of Western Australia. Rob received a Public Service Medal in 2007 for outstanding public service to the agriculture industries and the community of Western Australia.

Trade, travel, technology and turmoil - the drivers of plant biosecurity in the USA

Rebecca Bech, *Deputy Administrator, Animal and Plant Health Inspection Service's (APHIS) Plant Protection and Quarantine program United States Department of Agriculture*

Animal Plant Health Inspection Service (APHIS) is the United States Department of Agriculture Agency responsible for protecting American agriculture and natural resources. Within APHIS, Plant Protection and Quarantine (PPQ) is the front-line program responsible for protecting plant natural resources and agricultural plants/commodities from the actions of invasive alien species (IAS), such as plant pests, diseases, and noxious weeds. The PPQ biosecurity effort for the United States responds to four principal drivers, namely, *agricultural trade, human travel, biosecurity technology,* and *social/ economic turmoil.*

Statistical data is presented for the past 20 years to document significant increases in agricultural trade. Statistical data on passenger travel shows that the United States has experienced significant increases in travel to its country. Plainly, more people are traveling from distant places to the United States than in the past; more Americans are touring the world to visit exotic places rarely visited in the past. Consequently, tourism brings increased dangers of deliberate and accidental introduction of pests, diseases, and weeds.

Concomitant with increased trade and travel, PPQ has witnessed an increase in the interception of IAS at boarders associated with agricultural industries and an increase of IAS within natural habitats. This situation has increased the opportunities for IAS to become introduced, established, and negatively impact agriculture and commerce. Coupled with this trend, we also see a demonstrable increase in the number of invasive species being treated by emergency programs. Some notable active programs include Asian longhorn beetle, emerald ash borer, *Phytophthora ramorum,* citrus greening, citrus

canker and light brown apple moth to name a few. Collectively, these emergency control programs costs hundreds of millions of dollars and also shape regulatory priorities. The presentation discusses some innovative activities associated with emergency programs.

Improved biosecurity technology is a critical driver for PPQ. In response to challenges posed by IAS, biosecurity efforts have been driven to improve tools and technology that are used in survey, detection, identification, and mitigation of pests, diseases, and weeds. The presentation identifies some of the organizations involved in this work and briefly discusses some notable achievements driving research and development of science and technology in support of biosecurity. The scope of some collaborative efforts is explained and a justification for international collaboration is proposed.

Social and Economic Turmoil abound throughout the world and we see increases in IAS interception associated with illegal commerce. Smuggling Interdiction and Trade Compliance is a regulatory program that focuses on efforts to control illicit commerce. Illegal immigration also contributes to the movement of IAS in the United States, but the impact on biosecurity has not been precisely measured. The presentation briefly characterizes these efforts.

Biography: Rebecca Bech is the Deputy Administrator for Animal and Plant Health Inspection Service's (APHIS) Plant Protection and Quarantine (PPQ) program. Ms. Bech provides executive leadership and direction to a nationally dispersed staff responsible for safeguarding U.S. plant resources from destructive pests and diseases. She represents the USDA in international plant protection organizations and serves as the U.S. representative for the International Plant Protection Convention.

From April 2007 to January 2008, Ms. Bech served as the Deputy Administrator for APHIS' Biotechnology and Regulatory Services program. She joined APHIS in 1986, serving in numerous position including, a plant pathology identifier, branch chief for the National Identification Services, and the Director for Scientific Services. She led the National Invasive Species Initiative for the Department of Agriculture, serving as the USDA Liaison for Invasive Species, representing the Secretary's office.

Ms. Bech holds degrees in plant science and plant pathology and a Master's degree in education.

Biodiversity impacts of invasive animals

Mick Clout, *Director, Centre for Biodiversity & Biosecurity, University of Auckland*

Invasive animals are a major cause of the loss and decline of native biodiversity in a wide range of ecosystems in many regions of the world. The threats that they pose have proved especially severe on oceanic islands and other isolated ecosystems. Introduced mammalian predators are perhaps the best-known offenders, but there are also some notorious examples of invasive birds, reptiles, fish and invertebrates that threaten native species and can transform natural ecosystems. Invasive herbivores can also cause biodiversity loss and may provide the prey base to support invasive predators. Ecological interactions between invasive animals are sometimes complex and unexpected, which can make their management a challenging process. Nevertheless, the capacity to prevent, detect, control or eradicate such species (especially on islands) has advanced greatly in recent years. Lessons learned from recent experience are summarised and the implications for potential restoration of native biodiversity are considered.

Biography: Mick Clout is a vertebrate ecologist. He has worked extensively on the ecology and behaviour of invasive mammals, and their impacts on native birds in New Zealand. Mick was the founding chair of the IUCN/SSC Invasive Species Specialist Group, which he led from 1993 to 2008. He is currently director of the Centre for Biodiversity and Biosecurity at the University of Auckland. He also chairs the NZ Biosecurity Impacts of Invasive Animals.

Biosecurity challenges for large multi-national resource projects

Johann van der Merwe, *Gorgon Quarantine Manager, Chevron Australia*

The Gorgon Gas Development will involve the construction and operation of facilities on Barrow Island, Western Australia to produce and export liquefied natural gas, condensate, domestic gas, and separate and geosequester reservoir carbon dioxide.

In their 2006 assessment of the proposal to construct the Gorgon Gas Development, the Western Australian Environmental Protection Authority concluded that the development of a Gorgon Gas Development on Barrow Island posed an unacceptable risk to the conservation values of Barrow Island,

in part due to the risk of introducing non-indigenous species which may lead to the loss of biodiversity. The Western Australian government proceeded to approve the project for implementation, on condition that the proponent could prove that the risk to introducing a non-indigenous species could be reduced to an acceptably low level.

This objective was achieved though the development of a comprehensive Quarantine Management System (QMS) based on a qualitative risk assessment that assessed quarantine risk to conservation values based on expert judgment. This approach involved community stakeholders and an independent Quarantine Expert Panel, in setting up a risk management methodology including Standards for Acceptable Risks that provided the benchmark for what was acceptable risk. This resulted in a biosecurity management approach that established a pre-border prevention program, post border detection program and an eradication capability in the event a non-indigenous species evaded the pre-border prevention measures.

As demand for resources push exploration into increasingly remote and biodiversity rich areas, the irreplacebility and vulnerability of the biodiversity of such areas may be the single greatest risk project proponents face in gaining environmental approval from governments. This case study demonstrates that through a systematic risk-based approach it is possible to develop an operational management system that can meet the objectives of a diverse range of stakeholders, and enable companies to gain approval to access to environmentally sensitive areas where the introduction of non-indigenous species may result in the loss of biodiversity.

Biography: Johann is an internationally recognised expert for protected area management, conservation planning, and biosecurity. He was the Director for South African National Parks, an organization entrusted with the management of some of the world's most vulnerable and irreplaceable biodiversity. He is also accredited with championing many of the first trans-boundary protected areas in Southern Africa and Southeast Asia. He has managed some of the world's largest invasive clearing programs in the catchments of high conservation value in South Africa. He was also responsible for the management of some of the world's most virulent veterinary diseases including anthrax, bovine tuberculosis, foot and mouth disease, feline aids, etc. Currently responsible for setting up a dedicated Quarantine Management System for the Gorgon Project.

Animal health surveillance systems

Angus Cameron, *AusVet Animal Health Services*

Surveillance plays an important role in biosecurity – to establish the status of the population and the hazards when programs are originally developed; to support risk analysis; and to provide ongoing assurance of the effectiveness of the measures introduced. Recent research in approaches to surveillance has provided a range of new opportunities to gather better quality and more cost-effective information for decision making.

In the area of freedom from animal diseases, risk-based surveillance can achieve a high probability of detecting disease at much lower costs. New analytical techniques allow data from risk-based and non-representative surveillance to be quantitatively analysed. Evidence from multiple existing (often passive) data sources can be quantified and combined to give a more complete picture of the disease situation. Furthermore, the value of historical data can be incorporated into estimates of current disease status.

Other tools including syndromic surveillance and advanced systems for the early detection of pattern anomalies provide improved approaches to the detection of previously unrecognised and potentially subtle emerging diseases.

However the emphasis on endemic disease surveillance has been decreasing. Information required for endemic disease management, risk analysis and priority setting is becoming less available. Creative cost-effective approaches are required to fill this gap.

The new surveillance tools provide a range of opportunities for animal and plant disease and pest surveillance. However, these new approaches are increasingly complex, requiring a detailed understanding of the risk structure of the population and of the surveillance processes, and the use of mathematical modelling and advanced statistical techniques.

To take advantage of the surveillance opportunities available two changes are required: firstly, a detailed understanding of the use and complexities of these new techniques; and secondly,

improvement of the global, regional, bilateral and local regulatory frameworks for surveillance to allow better, cheaper techniques to be adopted.

Biography: Angus Cameron is a veterinary epidemiologist with special interest in disease surveillance, freedom from disease, information systems and geographic information systems (GIS). He is director of AusVet Animal Health Services, a private epidemiology company. Angus shares his time between France and Australia, and is regularly involved in projects in Australia, Asia, Europe, North America and Africa

Risk analysis to safeguard agriculture and natural biological systems

Robert L Griffin, *Plant Epidemiology and Risk Analysis Laboratory, USDA-APHIS, Plant Protection and Quarantine, Center for Plant Health Science and Technology*

The fundamentals of risk analysis are well-known and have a long history of practice in many disciplines; however the systematic application of risk analysis in agricultural and environmental health is relatively new and evolving as a public decision-making tool. Challenges exist at many levels, including in particular the need for policy makers and stakeholders to have confidence in the products resulting from diverse and sometimes complex methodologies often fraught with high levels of uncertainty and political pressure. The issue is complicated by conceptual inconsistencies across related scientific disciplines, jargon that is peculiar to certain sectors, and underdeveloped processes within methodologies. Harmonization efforts driven by international trade obligations have promoted some level of consistency and increased the rate of evolution for risk analysis in the disciplines of plant and animal health and food safety without bridging these to environmental applications. The result is a growing perception that the application of risk analysis to environmental health issues is somehow different. This problem is exacerbated by the fractured nature of national government organizations with responsibility for agricultural and environmental issues and frequently demonstrated by ineffective and conflicting regulatory programs. Some governments have formed cross-agency councils to encourage the harmonization of regulatory strategies, although the ambit of these mechanisms has not typically reached to risk analysis. A more focused strategy could be to centralize risk analysis functions, but examples of this in practice are lacking. Whatever the strategy, the national and international struggle for consistency must take account of the need for risk analysis to continue evolving and emphasize the importance of transparency, honesty, and communication for external understanding and acceptance.

Biography: Robert Griffin is the Director of the Plant Epidemiology and Risk Analysis Laboratory within the Center for Plant Health Science and Technology with USDA-APHIS. He has a MS degree in plant pathology and 34 years experience in plant quarantine. From 1997 to 2003, he worked for FAO as Coordinator for the International Plant Protection Convention (IPPC) with primary responsibility for the elaboration of international standards for phytosanitary measures, including the standards which currently form the foundation for pest risk analysis (PRA) used globally by the phytosanitary community.

Threats and Impacts Stream Abstracts

(in presentation order)

The stripe rust pathogen of cereal crops in Australia: managing exotic and endemic threats to crop losses

Colin Wellings, *University of Sydney*

The winter cereal crops represent a significant economic contribution to the national economy, averaging AU$ 5 billion in annual earnings over the previous five years. The rust diseases of wheat have been estimated to have the potential to inflict losses approaching AU$ 300 million per year in situations where no control strategies are applied.

The stripe rust pathogen (*Puccinia striiformis*) of winter cereal crops in Australia has caused significant economic losses during its relatively brief history since 1979. This pathogen first arrived as an exotic introduction from Europe, followed by adaptation and population evolution that resulted in the demise of commercial cultivars, the loss of quality and quantity of grain in certain seasons, and the imposition of increased costs of production in fungicide application. The stripe rust epidemics in Australia from 2003-2008 have been estimated to have imposed $40-90 million in fungicide costs each year.

Annual surveys of the pathogen population across the entire Australian winter cereal production zones have been a component of the Australian Cereal Rust Control Program, hosted by The University of Sydney (Cereal Rust Lab, Plant Breeding Institute) and funded by Grains Research & Development Corporation. The annual surveys of *P. striiformis* have been based on assessments of samples on sets of differential genotypes in greenhouse tests. The data has provided evidence of mutation, a further two instances of exotic introduction and support for the role of naturaled weedy communities of *Hordeum spp*. in pathogen evolution.

A thorough and continuing study of local cereal rust pathogen populations, and active engagement in cereal rust research in international agriculture, places the Australian cereals industries in a strong position to recognise potential threats. The paper will outline some important examples of local and exotic threats from *Puccinia striiformis*, and the implications these have for implementing disease control strategies.

Biography: Colin Wellings has been on secondment from NSW DI&I to The University of Sydney's Cereal Rust Lab since 1980. In this time he has focused on studies of the stripe rust pathogen, including population dynamics, host resistance and international efforts to monitor the pathogen across continental zones known to be at risk to the disease.

Characterisation of Indonesian H5N1 isolates to understand the prolonged infection and spread of H5N1 among domestic poultry

Hendra Wibawa, Harimurti Nuradji, Joerg Henning, *University of Queensland,* John Bingham, *Australian Animal Health Laboratory,* Frank Wong, *Australian Animal Health Laboratory,* Sue Lowther, Jean Payne, Jenni Rookes and Joanne Meers, *University of Queensland*

Highly pathogenic avian influenza (HPAI) caused by H5N1 virus has caused devastating outbreaks of disease in poultry populations around the world and has also resulted in deaths in humans. Indonesia is one of the countries most severely affected by H5N1 virus in terms of both poultry and human health. Although many control measures including stamping-out, vaccination, biosecurity and surveillance, have been implemented in Indonesia since 2004, HPAI H5N1 outbreaks still occur frequently in traditional sectors of poultry management. Domestic ducks may be an important source of H5N1 virus in Indonesia. We are currently investigating the role of ducks in maintaining H5N1 infection and shedding virus over prolonged periods. In this work we aim to determine the genetic and antigenic characteristics of H5N1 viruses isolated from small-holder duck farms in Indonesia and to describe the pathogenicity of two of these duck-derived isolates in ducks and chickens. Over 100 virus isolates were obtained during a longitudinal field study and disease outbreak investigations in Central Java. The nucleotide sequences of haemagglutinin (HA) and neuraminidase (NA) genes of selected isolates were analysed and antigenic mapping using haemagglutination inhibition data was performed. Groups of 14 chickens and 14 ducks were challenged with virus isolates from H5N1 subclades 2.1.1. and 2.1.3 and the birds were monitored for clinical signs, virus shedding and tissue distribution of virus. Results of these studies will be presented. This experimental and molecular research will help to understand the

HPAI epidemiology we observe in the field and may lead to improved methods to prevent future outbreaks.

Biography: Hendra Wibawa is currently a PhD student based at the Australian Animal Health Laboratory and funded by the Australian Centre for International Agricultural Research. He is a veterinarian from the Disease Investigation Centre at Wates, Indonesia where he heads the molecular diagnostic laboratory.

Factors affecting the introduction, distribution, migration and colonisation of currant-lettuce aphid *Nasonovia ribisnigri* (Mosley) in Australia

Craig Feutrill, *Cooperative Research Centre for National Plant Biosecurity and University of Adelaide, Waite Campus*, Mike Keller, *University of Adelaide, Waite Campus*, Sandra McDougall and Jianhua Mo, *NSW Agriculture, Yanco NSW*

Currant-lettuce aphid (CLA), *Nasonovia ribisnigri*, migrated from New Zealand to Tasmania on low-level jet streams in January 2004 and spread throughout Australia within two years. CLA is primarily a contamination pest that colonises lettuce hearts and rosettes, rendering them unsalable. Like many small winged insects, aphids migrate predominantly via wind and human activity. The timing and distance of their dispersal is influenced by many factors including plant quality, photoperiod, temperature and weather events. Understanding how such factors interact is critical to determining the size of quarantine zones. To investigate factors critical to aphid dispersal, six nine-metre fully automated suction traps for sampling winged CLA were built and placed at strategic locations in southeastern Australia. The traps sample 45 cubic metres of air per minute, which is funneled into a fine mesh cone dropping insects into 70ml jars containing polyethylene glycol. Trap catches are segregated daily, which allows analysis of the effects of temperature, wind direction and run, and rainfall events on aphid numbers. Abiotic factors such as plant water availability, nutrition and ambient temperature can also play a major role in initiating insect dispersal through an increase in the development of alate adults. Experiments were conducted to determine the effects of varying water availability on alate production. CLA were introduced to caged lettuce plants with low, medium and high levels of water available to them. Ten alates were released onto each plant, and plants were destructively sampled after 10 days at 20° C (one generation of CLA) to determine the numbers of alate and apterous 4th stage nymphs. No significant effect of water availability on the alate development of 4th stage CLA was observed. To discount the breeding predisposition of adult parthenogenetic alate CLA, further split-plot experiments will be undertaken.

Biography: Craig graduated from the University of Adelaide with Honours in Entomology in 1987. After working for 10 years as a field entomologist, initially for Yandilla Park and then his own company Horticultural Pest Management Services, he moved into the field of information technology starting a company with two other researchers. The company, Arris, worked primarily in translating research outcomes into easy-to-use information for the primary production industries. In 2007 Craig sold his shares in Arris and began this current project.

Foxes and on-farm biosecurity: have they a role in bovine *Neospora* abortion?

Jessica King, *Invasive Animals Cooperative Research Centre and Faculty of Veterinary Science, University of Sydney*, J Slapeta, *Faculty of Veterinary Science, University of Sydney*, D Jenkins, *Charles Stuart University*, J Ellis, *University of Technology Sydney* and P Windsor, *Faculty of Veterinary Science, University of Sydney*

We are investigating the potential role of invasive animals in the transmission of *Neospora caninum* in Australia. Bovine neosporosis is a protozoal reproductive disease caused by *N. caninum*, manifest by both major outbreaks and sporadic cases of abortion outbreaks. The disease is estimated to cost the Australian dairy and beef industries an average of AU$30 million per annum. Research has shown that vertical transmission alone, in which the cow transfers the parasite to its foetus, is insufficient to sustain infection in a herd and overseas work has implicated domestic dogs and coyotes as definitive hosts of the disease. We have been investigating whether Australian wild canids are capable of shedding infective oocysts that contaminate pasture and water on farms and infect livestock.

Seroprevalence surveys of *N. caninum* in cattle have determined that a large proportion of herds with the disease are located along the coastal areas of New South Wales and Queensland and in close proximity to bushland where Australian wild canids (dingoes, dingo/domestic dog hybrids, foxes) are common. To determine if these animals provide the missing link in the transmission of the disease to cattle, we conducted experimental transmission trials that recently identified Australian dingoes as definitive hosts of *N. caninum.* However, evidence to suggest that Australian foxes may be transmitters of the disease is lacking. To determine whether foxes pose a biosecurity threat to livestock on New South Wales farms through transmission of *N. caninum*, surveys have been undertaken in cattle and red foxes by pathology and molecular identification of the disease agents. Current data will be presented that is likely to resolve whether the presence of wild canids is a risk factor for neosporosis. This information is of importance if claims that control of wild canid populations on and in areas adjacent to farms, is a necessary management procedure in an on-farm biosecurity program, to control neosporosis and limit the risk of bovine abortion.

Biography: Jessica King is a postgraduate candidate with the Invasive Animals CRC, at the Faculty of Veterinary Science, University of Sydney. She completed a Bachelor of Animal and Veterinary Science degree at the University of Sydney and is currently undertaking her PhD on the epidemiology of *Neospora caninum*, investigating the role of wildlife and wild canids in the transmission of the disease. This research is supported through a stipend from the Invasive Animals CRC and the Dr William Richards Award in Veterinary Pathology (USyd) and the NPH Graham Scholarship for Sheep Research (USyd).

Australian plant susceptibility to *Phytophthora ramorum* and their role in driving a potential epiphytotic

Kylie B Ireland, *Cooperative Research Centre for National Plant Biosecurity and Faculty of Sustainability, Environmental and Life Sciences, Murdoch University,* D. Hüberli, *Department of Agriculture and Food*, B. Dell, *Faculty of Sustainability, Environmental and Life Sciences, Murdoch University*, I. W. Smith, *Department of Forest and Ecosystem Science, University of Melbourne*, D.M. Rizzo, *Department of Plant Pathology, University of California* and Davis G.E. St J. Hardy, *Centre for Phytophthora Science & Management, Faculty of Sustainability, Environmental and Life Sciences, Murdoch University*

Phytophthora ramorum is an invasive plant pathogen causing considerable and widespread damage in nurseries, gardens and natural woodland ecosystems of the USA (where it causes Sudden Oak Death) and Europe, and is classified as a Category 1 plant pest in Australia. It is of particular interest to Australian plant biosecurity as, like *P. cinnamomi,* it has the potential to become a major economic and ecological threat in areas with susceptible hosts and conducive climate. Research was undertaken in California to assess the pathogenicity of *P. ramorum* on Australian native plants. Sixty-nine test species within 24 families were sourced from established gardens and arboretums, and selected based upon provenance from areas of climatic suitability for *P. ramorum* as well as ecological and economical importance. Foliar, branch and log susceptibility was tested using detached leaf, branch and log assays. Sporulation potential and chlamydospore production was tested on detached foliage. Seventy-seven percent of all inoculated leaves were found to be infected with *P. ramorum*, with all species demonstrating some level of susceptibility, and some asymptomatic infection recorded. Disease incidence and severity were greater during the summer, and when the leaves were wounded. Branch inoculations indicated some species may be affected by branch dieback, but only the juvenile foliage of *Eucalyptus leucoxylon* displayed symptoms more severe than the positive control, *Rhododendron* "Colonel Cohen". Sporulation was recorded on a few species, particularly on juvenile foliage. Results of the studies will be discussed in relation to their implications for disease entry, spread and development of an epiphytotic within an Australian biosecurity framework.

Biography: Kylie Ireland is a PhD student with the CRC for National Plant Biosecurity at Murdoch University, Perth, Western Australia.

Bats and the emerging zoonotic disease threat

Gary Crameri, and Lin-Fa Wang**,** *CSIRO Livestock Industries, Australian Animal Health Laboratory and Australian Biosecurity CRC for Emerging Infectious Disease*

Bats are the most abundant, diverse and geographically dispersed vertebrates on earth with over 1000 species, representing approximately 20 per cent of all mammal species. Various bat species have recently been identified as the reservoir hosts of many emerging viruses responsible for severe human and livestock disease outbreaks. These include Hendra and Nipah viruses, SARS coronavirus, Ebola viruses and others. While these viruses result in significant morbidity and mortality in other mammals, they appear to cause no clinical consequence in bats under natural or experimental infection. Bats evolved and diverged from other mammals very early in evolution. Different from other mammals, bats possess several unique biological features that may play a role in their exceptional capacity in maintenance and transmission of viruses. With the increasing trend of novel zoonotic viruses emerging from bats of different species and causing deadly disease in humans and domestic animals, there is an urgent need to conduct basic studies into bat biology, immunology and ecology in order to better understand bat–virus interactions. Research into bat genomics, development of bat immunology tools, establishment of bat cell lines and consolidation of an international network for ecological and epidemiological studies of bats and bat viruses are needed. Understanding the key difference in pathogenesis and the mechanism of virus spillover from bats to other mammals will be critical for risk assessment and for prevention and control of future disease outbreaks caused by bat-borne zoonotic viruses.

Biography: Gary joined the Australian Animal Health Laboratory (AAHL) in 1985 and 10 years later with the emergence of Hendra in Brisbane moved into the Henipa Virus Research Group working in the newly established PC4 facility at AAHL. In 2003 with AAHL's involvement in SARS research, Gary became one of the initial members of the current team in the New and Emerging Zoonotic Diseases Research Stream. With 15 years working in the PC4 suit laboratory, including experience with SARS, Hendra, Nipah Malaysia and Bangladesh and recently Ebola, he is currently the most experienced BSL4 operator in Australia.

Red imported fire ants: the benefits of applied genetics to the eradication program

Jane Oakey, Craig Jennings, Cara McNicol, Jason Haffenden, Neil O'Brien and Keith McCubbin, *Biosecurity Queensland, Queensland Primary Industries and Fisheries*

Solenopsis invicta Buren (red imported fire ant, RIFA) is a Class 1 invasive pest, originating from South America. Infestations of RIFA have the potential to cause severe impacts upon agriculture, native ecology, economy and lifestyle. These impacts are a result of their aggressive defence mechanisms, including an alkaloid venom, and non-defence characteristics including large populations, rapid spread, and omnivorous feeding habits leading to predation and destruction.

In 2001, RIFA was detected in Brisbane in southeast Queensland and a national cost-sharing agreement was implemented to eradicate the infestation. In addition to passive and active surveillance and treatment processes, Biosecurity Queensland has undertaken genetic studies of sampled colonies throughout the infestation. This is providing an understanding of the population dynamics, inferred spread characteristics and effect of the eradication program, hence contributing to policy with respect to the ongoing surveillance and treatment process.

Genetic analysis has been conducted using large numbers of microsatellite loci identified by United States Department of Agriculture, Gainesville, Florida. The allelic data has been used to identify populations and sub-populations, interpopulation and intrapopulation relationships to infer spread patterns.

This presentation will describe a brief history of the infestation and the application of the population genetics to the benefit of the RIFA eradication program in Australia. Results will show that there have been three separate incursions into Queensland, two of which appear to have been eradicated. In one of these we have not detected RIFA since 2006, we have completed operations and anticipate a RIFA-free status.

Biography: Dr. Jane Oakey is the senior molecular biologist in Biosecurity Queensland, Queensland Primary Industries and Fisheries, based at the Biosecurity Sciences Laboratory in Brisbane. After 20 years of working with genomes of pathogenic microbes she moved onto larger organisms and for the last few years she has been genotyping invasive pests to help Biosecurity Queensland understand the kinetics of pest incursions.

Are we prepared for an exotic disease outbreak in feral pigs?

Steven Lapidge, *Invasive Animals Cooperative Research Centre*

Australia has long been concerned about the biosecurity threat posed by feral pigs. Over the last two decades numerous researchers have attempted to predict the likely rate of spread of foot-and-mouth disease and classical swine fever using deterministic and stochastic models to enhance our disease preparedness. We have taken a different approach based on molecular ecology techniques. Our study used microsatellite analysis of samples obtained from two consecutive years of aerial culling to obtain parentage data from a widely dispersed and low-density feral pig population during drought conditions in the semi-arid rangelands of Australia. This data was analysed geospatially to provide estimates on the actual minimum movements of feral pigs, from which transmission rates were estimated. Additional molecular research identified the appropriate management units for feral pigs over 1 million square kilometres in the Australian rangelands. More recently, rapidly deployable control tools to limit disease spread have been developed and registered, and quicker-acting agents more amenable to disease surveillance are being developed. Furthermore, the possibility to develop more proactive tools to minimising the exotic disease threat has been envisaged. Options may include disease vaccine baits deployed in potential incursion hot spots in a buffer-zone approach. This paper will discuss existing and potential approaches to maximising the preparedness of Australia and other countries for a disease outbreak in a free-living feral pig population.

Biography: Dr Steve Lapidge is the Program Leader of *Uptake of Products and Strategies* in the Invasive Animals CRC. The program is comprised of product development, field demonstration and commercialisation. He also holds positions as the Project Manager of feral pig research, Chief Scientific Officer of the biotechnology-transfer company Pestat P/L, and academic positions with the Universities of Canberra, Sydney and Adelaide. He completed a PhD at the University of Sydney in conservation biology, but has since focused his research on invasive species management after seeing first hand the devastating effects such species can have on Australia's unique biota.

Determining the natal origin of exotic pests using isotope and trace element geo–location markers

Karen F. Armstrong, Peter W. Holder, Tim J. Clough, *Lincoln University,* Russell D. Frew, *University of Otago*, Marc A. Millet, *Victoria University*, and George Gill, *MAF Biosecurity New Zealand*

Accurate geographic-origin information can be crucial for determining the most appropriate biosecurity response to an exotic pest incursion. High-profile examples in New Zealand have included post-eradication finds of gypsy moth, fall webworm and painted apple moth. Such "finds" could represent either undetected remnant populations or newly arrived unrelated individuals. These two scenarios not only have different implications for the success of expensive eradication campaigns, but require quite different operational responses. To resolve this, in the case of painted apple moth, an integrative approach using DNA and δ^2H and $\delta^{13}C$ stable isotopes as geo-location markers was considered. However the results were tenuous due to poor resolving power of these markers in a biosecurity context; that is, tracing single, accidentally introduced, polyphagous insects that originate from a broad geographic range. This was compounded by the rudimentary knowledge of isotopic variation across New Zealand's island locale. It was also in stark contrast to proven accuracy of δ^2H and $\delta^{13}C$ for migratory organisms with known food sources on large continents with good natural isotopic variation data[1].

[1] Hobson, K. A., L. I. Wassenaar, and O. R. Taylor. 1999. Stable isotopes (delta D and delta 13C) are geographic indicators of natal origins of monarch butterflies in eastern North America. *Oecologia* 120:397-404.

Justification for some costly biosecurity decisions in response to pest threats, however, still promises to be enhanced if accurate natal origins can be established. The same geo-location information is applicable not only for forestry pests, but to a range of situations including exotic thrips associated with recycled packing boxes or ants found at container transitional facilities. Establishing multi-element geo-location profiles would also augment other applications in forensics, ecology and pest management. Consequently, a multi-element geo-location dataset is being considered. . A novel method has been developed to profile single insects for the natural abundance of trace element stable- and radiogenic-isotopes. This is based on various mass spectrometry analyses and the globally distributed *Helicoverpa armigera* (Lepidoptera: Noctuidae) as a model phytophagous insect. Processes underlying the location-to-plant-to-insect biogeochemical profile imprinting in phytophagous insects are now being examined. To date, the multi-element, multivariate analysis indicates that geo-location clear discrimination within and between the New Zealand and Australian study regions is possible.

[1] Hobson, K. A., L. I. Wassenaar, and O. R. Taylor. 1999. Stable isotopes (delta D and delta 13C) are geographic indicators of natal origins of monarch butterflies in eastern North America. *Oecologia* 120:397-404.

Biography: Dr Karen Armstrong is a senior research officer in New Zealand's Bio-Protection Research Centre of Excellence. She specialises in the development of diagnostic tools for biosecurity, particularly the use of molecular techniques for the detection and identification of high-risk insect pests and pathogens at the border. Other interests include the exploitation of chemical and biochemical technologies to assist in intelligence gathering for biosecurity where molecular methods are inadequate.

Mobile mating disruption: using medflies against moths

David Maxwell Suckling, *The New Zealand Institute For Plant & Food Research* and Bill Woods, *Department of Agriculture and Food, WA*

New and more socially acceptable tactics are needed for the eradication of pest incursions, but there are many criteria that need to be met for the application of such tactics, often over large areas and sometimes in urban environments. Aerial application of biopesticides is a key eradication tool that enables cost-effective treatment of large areas. However, the adverse public reaction to aerial application of *Bacillus thuringiensis* in urban Auckland and Hamilton during the painted apple moth and gypsy eradication programmes highlighted these challenges. Further, the recent overwhelming public response in California against the aerial application of even the sex pheromone of light brown apple moth for mating disruption demonstrates the importance of having alternative and more socially acceptable technologies available to overcome such objections, or risk abandoning eradication for invasive alien insects.

One experimental but potentially useful generic eradication tactic builds on the successful development of mating disruption of moths, but involves treating and releasing sterile insects with micro-encapsulated sprayable moth sex pheromone. Several billion mass-reared sterile Mediterranean fruit flies (*Ceratitis capitata*) are released twice weekly in a range of countries, which represents a potential resource of inexpensive vector insects.

The invasive native Australian leafroller light brown apple moth (LBAM) (*Epiphyas postvittana*)(Lepidoptera: Tortricidae) is being used as a model species to develop this tactic, using sterile Mediterranean fruit flies as the vector. Trials in New Zealand showed that various insects such as moths or flies treated with synthetic moth sex pheromone could be rendered as attractive as female moths in traps. Treated Mediterranean fruit flies were then released into vegetation on street corners around replicated four-hectare plots in suburban Perth. Trap catch was completely suppressed for the first night, and significantly suppressed for the remainder of the week. The initial results were sufficiently promising to warrant further trials.

Biography: Max Suckling is Science Group Leader (Biosecurity) for the New Zealand Institute of Plant & Food Research, at Lincoln. His research team have been involved in several eradication responses, developing new approaches to surveillance and eradication, as well as integrated pest management in horticulture. They draw on core expertise in chemical ecology, including pheromone identification and development.

Benefit–cost analysis of the long-term containment strategy for exotic fruit flies in Torres Strait

Mary Ann Franco-Dixon, *Department of Employment, Economic Development & Innovation Queensland*

The Torres Strait Fruit Fly Strategy (TS FFS) was implemented in 1996 to address the continuing risk of exotic fruit fly incursion in Torres Strait and Far North Queensland.

The benefits accruing from the implementation of the strategy in this benefit–cost analysis was demonstrated using bananas as the case study fruit fly host commodity. Bananas are the most economically significant fruit fly host commodity, representing 38 per cent of the gross value of all commercial host fruit and vegetables grown in Australia in 2006-07.

In this study, the forgone benefits of trade in bananas that would occur without TS FFS were measured as well as the additional cost of insecticide sprays faced by banana producers in the event of exotic fruit fly incursion and establishment without the TS FFS in place. The savings in the costs of disinfestation were not included.

It should be noted that the benefits arising from the savings of costs which otherwise may be incurred if there was no TS FFS would be even larger if benefits in other fruits and vegetables that are potential hosts to fruit flies were included in the analysis.

Due to lack of information on population dynamics of these exotic fruit flies with and without the strategy, uncertainty was accounted for using Markov chain analysis.

At a discount rate of five per cent and a time frame of 10 years, the strategy costs of $1.97 million generated benefits of around $449 million. This resulted in a positive NPV of around $447 million and a benefit–cost ratio of 228:1.

Biography: Dr Mary Ann Franco-Dixon works for the Queensland government. She has a PhD and Masters degree in Agriculture and Resource Economics from the University of Queensland. She has also worked for the Food and Agriculture Organization of the United Nations, Asian Development Bank and European Union as an officer and/or as a consultant. Her work and research interests are biosecurity economics, livestock economics, animal health economics, water economics, and agriculture and research economics.

Siam weed (*Chromolaena odorata*): the true cost — beyond agricultural impacts to quantifying environmental impacts

Sarah L. Goswami, *Department of Employment, Economic Development & Innovation, Queensland*

To date, Siam weed has been recognised as a weed that causes significant agricultural damage, with the potential to aggressively invade pastures and agricultural cropping systems. In addition, Siam weed has the potential to seriously degrade ecosystems and inhibit ecosystem function. Whilst this latter impact has been recognised qualitatively, there has been no quantification of it. In evaluating the current eradication effort of Siam weed in Queensland, attempts were made to address this information gap to understand the true cost of Siam weed.

This paper will present key results of the cost–benefit analysis of the national Siam weed eradication program. From these results, discussion will be presented about the possible impact of Siam weed throughout the rest of Australia, in the event that spread occurs, and the implications for addressing Siam weed incursions.

Biography: Sarah Goswami is an economist/policy officer working with Queensland Primary Industries and Fisheries. She has been in this role for the past two years working on both the quantification of the impact of invasive species and evaluating the management options for dealing with invasive species. Sarah has a Bachelor's degree with Honours in environmental economics and is pursuing a Master's degree in public administration/policy advice.

Where and how much? Cost-effective surveillance for invasive species management

Cindy E. Hauser, *Australian Centre of Excellence for Risk Analysis, University of Melbourne*, Michael A. McCarthy, *Commonwealth Environment Research Facility (Applied Environmental Decision Analysis), University of Melbourne* and Joslin L. Moore, *Commonwealth Environment Research Facility (Applied Environmental Decision Analysis), University of Melbourne*

Surveillance for invasive species has typically been targeted to where the species is most likely to occur. However, spatially varying environmental features and land uses may affect more than just the probability of occurrence. Biodiversity or economic value, and the ease of detection and control are also likely to vary. We incorporate these factors into a detection and treatment model of a low-density invader to determine the surveillance strategy that minimises expected management costs. We apply our approach to the management of orange hawkweed (*Hieracium aurantiacum*) on the Bogong high plains of Victoria. Habitat suitability and dispersal modeling have provided predictions of where orange hawkweed is most likely to occur, while field trials have been used to estimate the probability of searchers successfully detecting the species. Robust optimisation methods indicate how we might adjust our surveillance strategy to accommodate uncertainty in our predictive modeling.

Biography: Cindy Hauser completed her PhD at the University of Queensland in 2006. Since then she has been employed as a post-doctoral fellow by the Australian Centre of Excellence for Risk Analysis, based at the University of Melbourne. Here she has developed quantitative methods for biosecurity surveillance planning, though her research interests extend more broadly to effective environmental decision making and planning in the face of uncertainty, incomplete knowledge and scarce data.

Multiple species detection: statistical aspects of surveillance design

Susan Barrett, Frith Jarrad, Sama Low Choy, Peter Whittle and Kerrie Mengersen, *Queensland University of Technology and Cooperative Research Centre for National Plant Biosecurity*

When designing a surveillance system to detect low density, invasive or rare species and when presence/absence is the outcome measure, a binomial probability model can be appropriate. However, a key statistical assumption in this type of model is that individuals in a species are independently and identically distributed with respect to the probability of detection by a trapping device. This means that each individual in a target species has the same underlying probability of detection by a trap, based on detection capability and footprint of that trap.

This independency however, does not always exist and the probability of detection can be different amongst individuals of a species, hence violating one of the assumptions of the binomial probability model. Researchers and field operatives are often aware of whether species display such behaviour. Although positive correlation or dependency between individuals of a species increases the number of traps required to detect any individual, and thus increases resource costs, ignoring such dependency reduces the efficiency and power of the surveillance system. To account for such dependent behaviour we present a simple modification to the binomial probability model by including a conditional probability in the design process.

Biography: Dr Susan Barrett is a Research Fellow in the School of Mathematical Sciences at Queensland University of Technology, Brisbane, Australia and received her PhD at Griffith University in 2007. She has a broad range of experience in statistical consulting and applied statistics. Her current work concerns the design of surveillance systems to detect invasive species.

Early detection, information gaps and the design of surveillance programs for invasive species

Denys Yemshanov, *Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre*, Frank H. Koch, *Department of Forestry and Environmental Resources, North Carolina State University, USDA Forest Service, Forest Health Monitoring Program*, Yakov Ben-Haim, *Technion, Israel Institute of Technology, Faculty of Mechanical Engineering* and William D. Smith, *USDA Forest Service*

Integrated risk maps and pest risk assessments provide broad guidance for establishing pest surveillance programs for invasive species, but they rarely account for knowledge gaps about the new threat or how these gaps can be reduced. In this study we demonstrate how the notion of information gaps and potential knowledge gains could be used in prioritising large-scale surveillance activities. We illustrate this approach with the example of an invasive pest insect recently detected in North America, *Sirex noctilio* Fabricius. First, we formulate the existing knowledge about the pest into a stochastic model and use the model to estimate the expected utility of surveillance efforts across the landscape. The expected utility accounts for the abundance, economic value and susceptibility of the host resource and the benefits of timely *S. noctilio* detections. Next, we make use of the info-gap framework to explore two alternative pest surveillance strategies. The first is to maximise the chance of timely detections (given the uncertainties about *S. noctilio* behavior); the second is to maximise the potential knowledge gain about the pests via unanticipated finds. In our case, we are uncertain both about the likelihood that this species is present at any given location and the odds of its detection, but we seek a geographical allocation of survey priorities that maximises the range of uncertainty over which the expected benefits from successful detections will nevertheless be gained.

The results include two sets of spatial outputs that can be used to prioritise surveillance efforts. The first set prioritises "certain" *S. noctilio* detections and the second maximises the potential of a survey to enhance the existing knowledge about the pest via unanticipated finds. These outputs are then aggregated via the Pareto ranking technique in a single priority map that outlines the survey regions with the best trade offs between both surveillance strategies.

Biography: Dr. Yemshanov joined the Natural Resources Canada in 2002. At the Canadian Forest Service his research specialisation can be described as development and integration of spatial modeling applications focused on various ecological and bioeconomic aspects of forest resources. Areas of his special interest include the development of integrated bioeconomic impact models and risk mapping / modeling techniques for forest invasive species. Other research activities include the bioeconomic modeling of carbon sequestration and offset policies and related land-use dynamics in Canada. Dr. Yemshanov received his PhD in ecology from the University of Dniepropetrovsk, Ukraine.

Landscape-scale surveillance of fungal plant pathogens undergoing aerial dispersal

David Savage, *University of Western Australia and Cooperative Research Centre for National Plant Biosecurity*, Martin J. Barbetti, *University of Western Australia, Department of Agriculture and Food Western Australia and Cooperative Research Centre for National Plant Biosecurity*, William J. MacLeod, Moin U. Salam, *Department of Agriculture and Food Western Australia and Cooperative Research Centre for National Plant Biosecurity*, Michael Renton, *University of Western Australia, Cooperative Research Centre for National Plant Biosecurity and CSIRO Sustainable Ecosystems*

A number of fungal plant pathogens of interest to biosecurity and pest management agencies alike undergo aerial dispersal. Such pathogens can be dispersed over large areas, resulting in multiple loci of infection and rapid spread of new pathogens and/or novel virulence into existing populations. The ability to reliably detect the aerial movement of fungal spores is an essential prerequisite for relevant agencies, both for effective identification of areas of greatest risk, and in order to provide targeted response to novel incursions.

The aim of this study is to employ computational models to estimate the relative effectiveness of a range of surveillance strategies in detecting dispersal events. A number of strategies will be tested differing in the spatial arrangement, type and number of surveillance devices employed. Attempts will be made to rank these strategies based on a simple cost–benefit analysis.

Modeling of surveillance strategies is performed by coupling of an existing model of aerial dispersal to a simple surveillance model capable of simulating both stationary and mobile surveillance devices. An outline of this modeling pipeline will be presented, along with some preliminary results demonstrating the use of this pipeline to assess the relative potential effectiveness of possible surveillance strategies.

Biography: David studied Mathematics at La Trobe University in Victoria and is currently a PhD candidate with the CRC for National Plant Biosecurity in the School of Plant Biology at the University of Western Australia.

Future–proofing surveillance: the challenges of emerging viruses and host switching

Deborah Middleton, *CSIRO*

Most human pathogens (868 species or 61 per cent of the total) are zoonotic; that is, they are naturally transmitted between humans and other vertebrates, and the majority of zoonotic emerging infectious disease (EID) pathogens originate in wildlife. The increase in wildlife-associated EID events over time suggests that they pose a significant threat to human health, with human population density and wildlife host species richness apparent predictors of EID events. However, there are many knowledge gaps about emergence mechanisms and how these pathogens become established in people. Understanding these factors is beginning to guide the development of smarter surveillance strategies within identified emerging disease "hotspots": ideally, this will lead to pre-emergent detection of new pathogens and thus proactive rather than reactive disease management. However, it remains unclear as to what is the optimum mechanism for acquisition of meaningful surveillance data from viral reservoirs in which there may have been prolonged co-evolution of virus and host. For emergent threats in which host switching has yet to occur, detection of the first unusual event in the spillover host may for some time yet remain the earliest indication of the existence of the pathogen. It is possible that separate kinds of surveillance strategies will need to be employed for managing the risk of "known" versus "unknown" emerging infectious diseases from wildlife: in both cases a focus on the interface of the host–pathogen complex with the physical landscape may be a critical factor for success.

Biography: Dr Middleton is a veterinary graduate of the University of Sydney, has a PhD in veterinary pathology and has over 30 years of experience in the experimental and diagnostic pathology of diseases of livestock, companion animals and wildlife. Currently, she is the leader of the Transforming Animal Biosecurity Research Theme at the CSIRO Australian Animal Health Laboratory. Particular research interests of this group include serious emerging zoonotic diseases such as Highly Pathogenic Avian Influenza, Henipavirus, SARS and other bat-borne viruses.

Mission Path Planning (MPP) for an Unmanned Aerial System (UAS) fitted with an air sampling device

Dr Felipe Gonzalez, *Queensland University of Technology* Dr D. Seop Lee, *International Center for Numerical Methods in Engineering* and Prof Rod W Walker, *Queensland University of Technology*

This paper presents advanced optimization techniques for the Mission Path Planning (MPP) of Unmanned Aerial Systems. In this application we considered a UAS fitted with a spore trap to detect and monitor spores and plant pathogens. The UAS MPP aims to optimise the mission path planning search and monitoring of spores and plant pathogens that may allow the agricultural sector to be more competitive and more reliable. A UAS can be fitted with an air sampling device or spore trap to detect and monitor spores or plant pathogens. Australia for instance is a large country, and the landscape is not always accessible and has agricultural areas that are in remote locations, where topography and climate conditions could make traditional monitoring and surveillance methods almost impossible. A UAS fitted with an air sampling device flying an optimal path can monitor and reduce the risk of pest introduction from international trade and, at the same time, will capture a wide range of plant health information in a cost-effective way so as to cover international and domestic market demands.

The optimal paths are computed using a Multi-Objective Evolutionary Algorithms (MOEAs). Two types of multi-objective optimisers are compared; the MOEA Non-dominated Sorting Genetic Algorithms II (NSGA-II) and Hybrid Game are implemented to produce a set of optimal collision-free trajectories in three-dimensional environment. The trajectories on a three-dimension terrain, which are generated off-line, are collision-free and are represented by using Bézier spline curves from start position to target and then target to start position or different position with altitude constraints. The efficiency of the two optimization methods is compared in terms of computational cost and design quality. Numerical results show the benefits of coupling a Hybrid-Game strategy to a MOEA for MPP tasks.

Biography: Dr Gonzalez has a PhD in Aeronautical Engineering from The University of Sydney. He is a lecturer at Queensland University of Technology and one of the lead researchers at the Australian Research Centre for aerospace Automation (ARCAA). He has developed three operational UAS and has

published over 20 journal and refereed conference articles on the topic of unmanned aerial systems and optimisation.

Modelling the proximal source of intercepted exotic insects

Darren J. Kriticos, *CSIRO*, Sylvain Guichard, Sue P. Worner, John Kean and Agathe Leriche

Some biosecurity systems, aimed at preventing the establishment and spread of invasive alien species, employ sentinel trapping systems to detect the presence of unwanted organisms. Having identified the presence of an invasive alien species through a trap catch, the next challenge is to locate the source of the incursion. Tools that can direct search effort towards the most likely sources of an incursion can improve the chances of identifying the introduction pathway, and consequently delimiting and eradicating the local population. The ground-based detection and delimitation surveys can be very expensive, and methods to focus search effort to those areas most likely to contain the target organisms can make these efforts more effective and efficient. An individual-based semi-mechanistic model was developed to simulate the spatiotemporal dispersal patterns of an invasive moth. The model combines appetitive and pheromone anemotaxis behaviours in response to wind, temperature and pheromone conditions. The model was trained using data from a series of mark-release-recapture experiments on painted apple moth, *Teia anartoides*. The model was used to create hindcast simulations by reversing the time course of environmental conditions. The ability of the model to encompass the release location was evaluated using individual trap locations as starting points for the hindcast simulations. The hindcast modelling generated a pattern of moth flights that successfully encompassed the origin from 86 per cent of trap locations, representing 95 per cent of the 1464 recaptures observed in the mark-release-recapture experiments. Comparing the guided search area defined using the hindcast model with the area of a simple point-diffusion search strategy revealed an optimised search strategy that combined searching a circle of one kilometre radius around the trap followed by the area indicated by hindcast model predictions. Incorporating this novel moth dispersal model into biosecurity sentinel systems will allow incursion managers to direct search effort for the proximal source of the incursion toward those areas most likely to contain natal sites for the unwanted moth. This targeted effort should reduce costs and reduce the time taken to detect the proximal source of the incursion.

Biography: Dr Darren Kriticos is a principal research scientist with CSIRO Entomology. He has interests in improving climate-based species niche modeling methods for biosecurity, projecting the impacts of climate change, and identifying options for adapting to those future challenges and developing population dynamics models for biological control and pest management.

Contribution of general surveillance to demonstrating area freedom for grain pests

Nichole Hammond, *Cooperative Research Centre for National Plant Biosecurity, Murdoch University, Western Australia and Department of Agriculture and Food, Western Australia* Tony Martin, *Department of Agriculture and Food, Western Australia and Australian Biosecurity Cooperative Research Centre for Emerging Infectious Diseases* and Cindy Hauser, *Australian Centre of Excellence for Risk Analysis, University of Melbourne*

General surveillance includes activities other than specific or targeted surveillance. This type of surveillance can include information from sources such as samples received for pest identification or disease diagnosis, reports through phone-in lines or for newsletters, and phone calls to area specialists. Information gathered through general surveillance has historically been used to support claims of freedom from plant pests, but its contribution has not been formally evaluated. General surveillance also has an important role in early detection, with many new detections made via reports from the wider community.

Scenario tree methodology has been applied in a number of animal disease situations to evaluate the contribution of passive surveillance activities with mixed results. In this paper we report on its application to general surveillance in Western Australia for the exotic plant disease Karnal bunt (*Tilletia indica*).

Due to the size and geographical spread of the grain industry in Australia, implementing targeted surveillance programs can be very expensive. Therefore, general surveillance plays an important part in the national and state surveillance systems. Understanding the sensitivity of the current general surveillance systems is very important in understanding overall capacity both to detect an introduction of an exotic pest of grains, and to support claims of freedom.

We assessed the current community reporting mechanisms for exotic grain pests, including sample submission to plant diagnostic laboratories, calls to phone advice lines, calls to the national reporting hotline, calls to area specialists, and reports to a newsletter published during the growing season. This analysis provides estimates of the sensitivity of the general surveillance system for detection of *T. indica*, and of the contribution general surveillance can make towards demonstrating area freedom for this pathogen.

Biography: Nichole is undertaking a PhD at Murdoch University, Western Australia, and is supported by the CRC for National Plant Biosecurity. Her PhD research is looking at methods for evaluating surveillance, and surveillance tools for demonstrating freedom from plant pathogens.

Prior to undertaking her PhD Nichole worked for the Western Australian Department of Agriculture and Food for eight and a half years in a number of biosecurity-related fields within the plant pathology section, including diagnostics, surveillance, pest risk analysis and plant health policy.

Toward practical, PCR-based detection methods for the surveillance of marine pests from ports and waterways

Nathan J. Bott, Marty R. Deveney, *Aquatic Sciences, South Australian Research and Development Institute*, Alan McKay and Kathy M. Ophel-Keller, *Sustainable Systems, South Australian Research and Development Institute*

Accurate and rapid diagnosis of marine pest species is central to their control. The Australian *National System for the Detection and Management of Marine Pests* requires tools for the detection and monitoring of marine pests. We are currently developing a capability for the specific and sensitive quantitative polymerase chain reaction (QPCR)-based detection of invasive marine pest species from the marine environment. Various projects are currently underway for the development and refinement of assays for the detection and enumeration of four marine invertebrate pest species: Asian bag mussel (*Musculista senhousia*), European clam (*Corbula gibba*), green-lipped mussel (*Perna canaliculus*) and vase tunicate (*Ciona intestinalis*). These will complement assays previously developed for giant fanworm (*Sabella spallanzanii*), Pacific oyster (*Crassostrea gigas*) and northern Pacific seastar (*Asterias amurensis*). Putative *Taq*Man Minor Groove Binding (MGB) QPCR assays will be rigorously screened with a wide range of heterologous controls to confirm specificity, and a range of environmental samples from various locations (both water and sediments) will be spiked with target organisms to determine detection limits. These quantitative assays will have the potential to be utilised for the detection of larval stages in environmental samples (water and sediments) as well as ship ballast water and fouling, and will allow more effective management and control strategies to be implemented. Developments in water sampling methodology and protocols for molecular analysis will be discussed. Future studies will explore the development of sensitive and specific QPCR assays for other marine pests of significance.

Biography: Dr Nathan Bott currently holds the position of MISA Research Scientist, Molecular Diagnostics at SARDI Aquatic Sciences. Since 2000 he has conducted research and consultancy services on a wide range of parasitic and free-living taxa and specialises in the development of molecular diagnostic assays for the surveillance of aquatic pathogens and pests, and livestock parasites. Nathan has published his work in peer-reviewed scientific literature on taxonomy, phylogenetics, life-cycles, molecular biology and diagnostics. Nathan's current research is focussed upon the development of effective molecular diagnostic methods for the detection and surveillance of marine invasive species and aquaculture pathogens.

Full genome sequencing and its application in the identification of new biosecurity threats

Simone Warner, Keith Savin, *Department of Primary Industries Victoria*, Frank Wong, *CSIRO Livestock Industries, Australian Animal Health Laboratory*, Mark Fegan, T. Sawbridge, M. Lancaster, N. Kvalheim, I. Mohammad, *Department of Primary Industries Victoria*, S. Corbeil, *CSIRO Livestock Industries, Australian Animal Health Laboratory* and M. Crane, *CSIRO Livestock Industries, Australian Animal Health Laboratory*

Access to diagnostic tests that are rapid, reliable and sensitive is fundamentally important for the effective control and management of disease outbreaks. Over the last several years, laboratories worldwide have been developing molecular diagnostic techniques. This can be a straightforward process for known viruses but can be extremely difficult when the pathogen is a newly emerged, or relatively unknown, virus, as is the case with many biosecurity threats.

In December 2005 in Victoria, Australia, a newly emerged virus caused an outbreak of abalone viral ganglioneuritis (AVG) in both farmed and wild abalone. The aetiologic agent was identified as a herpes-like virus via histopathology and electron microscopy. Attempts to eliminate the disease failed partly due to the lack of pathogen-specific detection methods, which prevented early diagnosis of infected animals. Molecular diagnostic tests such as PCR or *in situ* hybridisation would have greatly facilitated disease diagnosis, however no such tests, or the required sequence information for their design, were available.

DNA was extracted from virus purified from pooled abalone nerve tissue and subjected to multiple displacement amplification. This generated template for direct ultrahigh-throughput DNA sequencing using the 454 Biosciences™ Genome Sequencer™-FLX System. Characterisation of the abalone herpes-like virus via *de novo* assembly and annotation of the generated DNA sequences was conducted. Assembled contigs were initially analysed by BlastX comparison to the genome of ostreid herpesvirus OsHV-1, a virus that causes similar disease pathology in oysters and other bivalves.

The genome sequence of the abalone herpes virus is nearing completion. Conventional PCR, real time PCR and *in situ* hybridisation assays have been developed that can be used to complement other traditional tests to confirm AVG in abalone. This project highlights the usefulness of using whole genome sequencing to achieve worthwhile results for downstream use in diagnostic investigations and test development for newly emerged viruses.

Biography: Dr Warner has been working as a microbiologist for the past 20 years, and currently works for the Department of Primary Industries, Victoria. In the role as Statewide Leader for Microbiology, Dr Warner leads a group of almost 60 people in various areas of veterinary and plant bacterial and viral research, particularly in the area of biosecurity.

Using next-generation sequencing methods for diagnostics development: examples from phosphine resistance

David Schlipalius, *Queensland Primary Industries And Fisheries, Cooperative Research Centre for National Plant Biosecurity and The University of Queensland*, Andrew Tuck, *Queensland Primary Industries And Fisheries and Cooperative Research Centre for National Plant Biosecurity,* Rajeswaran Jagdeesan, Ramandeep Kaur, *The University of Queensland,* Patrick J. Collins, *Queensland Primary Industries And Fisheries and Cooperative Research Centre for National Plant Biosecurity* and Paul R. Ebert, *The University of Queensland*

Developing a gene-based diagnostic tool for a trait like phosphine resistance presents the formidable task of identifying as little as a single causative nucleotide change present in a highly polymorphic genetic background. The advent of next-generation sequencing methods, such as the Roche GS-FLX system and the Illumina Genome Analyser (GAII) system have made it possible to get very large amounts of sequence data from non-model organisms and specific strains of organisms in a relatively short time. This has made it possible to sequence whole transcriptomes and whole genomes from specific strains and to rapidly scan for polymorphisms that associate with particular traits of interest in any given organism. We have used this approach to target candidate genes for fumigant (phosphine) resistance in two pest insect species of stored grains, *Tribolium castaneum* and *Rhyzopertha dominica*, one of which has a reference genome and one that previously had almost no genome sequence

information associated with it. To date, we have resequenced the genome from selected resistant *T. castaneum*, generating 3.5 Gb, or approximately 15 times coverage of the genome, in a single sequencing run. We have identified two regions that appear to associate with resistance and are currently working on confirming the candidate genes identified. While we have used next-generation sequencing for targeting pesticide resistance, it should be noted that a similar approach could potentially be used to target any trait of interest in almost any organism. Given the speed in increase of sequence data acquisition, in the future traits that differ subtly between strains of diseases or pests, such as virulence or disease resistance could be identified with relative ease.

Biography: Dr. David Schlipalius began his PhD at the University of Queensland in 1999 on a GRDC scholarship studying the molecular genetics of phosphine resistance in the Lesser Grain Borer, *Rhyzopertha dominica*, and produced the first genetic linkage map of that beetle.

He has also spent a couple of years working on honeybee genomics as a postdoctoral researcher at Purdue University in Indiana, USA. He is listed as part of the Honeybee Genome Sequencing Consortium that published the Honeybee Genome Project and worked on the construction of a detailed genetic linkage map to help define genes involved in behaviour, including the stinging behaviour of Africanised ("killer") bees in the Americas.

Since then he has returned to Australia and the stored grains research field to complete the detailed genetic analysis of phosphine resistance.

Development and validation of molecular diagnostic protocols to support quarantine and certification programs for Australian horticulture industries

Fiona E. Constable, Mirko Milinkovic, Chris Bottcher and Brendan C. Rodoni, *Department of Primary Industries Victoria*

Australia is geographically isolated from many serious pests and diseases that cause significant losses in agricultural crops and strict quarantine regulations are enforced to protect Australian agricultural industries from these organisms. As a frontline defence, Australia has post-entry quarantine facilities where imported live plants are tested for prescribed quarantinable pathogens. In addition, improved productivity and sustainability of the Australian horticultural industries, including pome fruit, strawberries and viticulture, are dependent on the provision of high-health planting material that is routinely tested for prescribed endemic pathogens, particularly viruses, which have not been detected.

Detection of many quarantinable and endemic viruses has relied on the use of time-consuming bioassays that are dependent on the successful transfer of virus to a sensitive indicator plant, which shows specific symptoms associated with the pathogen. For some viruses, ELISA tests are also available; however, recent research indicates that this technique for virus detection may not be as sensitive as molecular methods such as polymerase chain reaction (PCR). In recent years, there have been some significant advances in molecular diagnostics for plant pathogens, and tests for most of the viruses associated with diseases of strawberries, pome fruit and grapevines have been developed elsewhere. At DPI Victoria we have been identifying, developing and validating the latest molecular diagnostic protocols available to detect quarantinable and endemic viruses of pome fruit, strawberries and grapevines in Australia. In all cases, reverse transcription PCR (RT-PCR) tests were developed and validated. We have also developed sampling strategies to improve the chance of pathogen detection. These tests will update and enhance the capability of Australian pathologists to accurately and efficiently diagnose the major quarantinable and endemic viruses of these three horticultural industries and provide both post-entry quarantine (PEQ) and high-health certification programs with best practice diagnostic capabilities for virus detection.

Biography: Dr Fiona Constable has18 years experience in plant virology and is currently employed as a research scientist with the Department of Primary Industries, Knoxfield, Victoria. She is actively developing and validating rapid and reliable diagnostic techniques for the detection of endemic and exotic pathogens (particularly viruses, viroids and phytoplasmas) of horticultural crops.

Acaricide resistance in cattle ticks — current status, future trends and new technologies

Louise A. Jackson, *Biosecurity Queensland*, Ralph G. Stutchbury, *Queensland Primary Industries and Fisheries* and John A. Allen, *Queensland Primary Industries and Fisheries*

The cattle tick *Rhipicephalus (Boophilus) microplus* is an ectoparasite of cattle in tropical and sub-tropical regions of the world, including Australia. Ticks and the diseases they transmit cost the northern Australian beef industry AU$170–200 million per year. Acaricides are chemicals used for the control of cattle ticks, and ticks have developed resistance to the succession of acaricides brought onto the market. Information on the acaricide resistance profiles of cattle ticks in the field is necessary to manage the use of acaricides. This will ensure the appropriate use of an acaricide and, more importantly, prolong the useful life of commercially available acaricides. Currently the resistance of the cattle tick to the various classes of acaricide is detected and measured using *in vitro* techniques (e.g. larval packet test and the adult immersion test). These tests are labour intensive, expensive and time consuming (taking up to eight weeks for a result). A molecular test for diagnosis of resistance to synthetic pyrethroids has been developed and there is ongoing research into producing molecular tests for the diagnosis of resistance to other acaricides. A panel of molecular tests for acaricide resistance in ticks would provide improved turn-around time for test results and reduced costs overall. The application of traditional tests and new technologies to acaricide resistance of cattle ticks will be discussed.

Biography: Louise Jackson is Senior Parasitologist at the Biosecurity Sciences Laboratory, Queensland Primary Industries and Fisheries, Brisbane. Her current activities include diagnostic parasitology, diagnosis and research into acaricide resistance of ticks and the development of an improved cattle tick vaccine. She has over 20 years research experience on ticks and tick-borne diseases.

Diagnostic tools to support quarantine pathology laboratories

Linda Zheng, Brendan Rodoni, *Cooperative Research Centre for National Plant Biosecurity and Department of Primary Industries*

Plant viruses cause diseases to crops worldwide and pose a threat to global plant biosecurity. Accurate, reliable and timely detection and diagnosis of new and emerging plant viral diseases is therefore crucial to protecting Australian agriculture. We report the development and evaluation of generic PCR assays that are capable of detecting groups of related pathogens, and an investigation on the feasibility of FTA technologies (Whatman, England) for rapid and safe collection and storage of viral RNA.

A key component of a generic PCR assay is the design of group-specific primers, as they determine both the sensitivity and specificity of the assay. A systematic approach was used for group-specific primer design, whereby the conserved sites within plant viral genomes were identified based on five different measures of sequence variability and ranked using their perceived rate of consensus decay over time. Several sets of group-specific primers have been designed and validated for the detection of species within a plant virus genus. Our findings support a systematic approach to the primer-design process to improve the capacity of plant virus detection and diagnostics.

FTA card technology was primarily designed and used for the transport of nucleic acids. RNA can be stored on FTA cards, but the quality of the stored RNA is not known. A quantitative reverse-transcription PCR assay was developed to assess the degradation rate of the RNA stored over time. Results from the study will benchmark the application of FTA cards for the storage of plant RNA and determine the usefulness of FTA cards to support active surveillance and incursion management programs. If successful, this method could be used for the safe movement of plant RNA across quarantine borders.

Biography: Linda Zheng graduated from Bachelor of Biomedical Sciences with honors from the University of Melbourne in 2004. Miss Zheng's interest in genetics and functional genomics sees her undertaking a doctor of philosophy program in Ecology, Evolution and Systematics from The Australian National University, Canberra. During her candidature, Miss Zheng investigated the implications of plant virus discovery in the genus *Potyvirus* on their detection and developed a novel method of designing group-specific degenerate primers for virus detection. Miss Zheng is now working on a CRC

for National Plant Biosecurity-funded project "Post-Entry Quarantine" where she continues to explore the world of plant virus diagnostics.

Enhanced surveillance strategies for grapevine phylloxera

Kevin Powell, Rebecca Bruce, *Department Of Primary Industries Victoria,* David Lamb, *Precision Agriculture Research Group*, John Runting, *Grape Advice Pty Ltd* and Ary Hoffmann, *Centre For Environmental Stress and Adaptation Research*

Grapevine phylloxera (*Daktulosphaira vitifoliae* Fitch) is a significant viticultural insect pest worldwide. It is particularly a threat in Australia, with over 80 per cent of grapevines planted on highly susceptible, ungrafted *Vitis vinifera* L. Early detection of phylloxera is critical as it can spread unnoticed in the early years of infestation when vine symptoms may not be obvious. Biosecurity measures such as phylloxera exclusion zones (PEZ) and a number of protocols relating to machinery and movement of grape materials are in place within Australia in an attempt to contain its spread throughout viticultural regions. Such measures are particularly important for regions like the Hunter Valley in New South Wales and the Barossa in South Australia, which are phylloxera free.

Currently, early detection relies on systematic sampling of plant roots to inspect for the presence of phylloxera, and has included multispectral aerial imagery to identify potentially stressed vines. Whilst the former is labour intensive, aerially identified vineyard weak spots may not necessarily be due to phylloxera infestation, rather the expression of non-specific water- or nutrient-related symptoms. Healthy canopy vigour may also disguise the expression of above ground signs of root degradation.

The delayed appearance of visible symptoms, coupled with the dynamics of phylloxera infestation means current phylloxera detection methods would be improved through development of an approach based on biophysical descriptors that directly indicate the potential susceptibility of vineyards to phylloxera infestation. This paper reports on the use of spatially-registered measurements to create a grapevine susceptibility matrix. These include photosynthetically-active biomass (PAB) in the vine canopy (Greenseeker^{TM}), soil electrical conductivity (EC_a) derived using EM38, a variety of analytical techniques, and direct measures of phylloxera incidence including a soil-based DNA probe and emergence trapping. Preliminary observations from a trial conducted in phylloxera-infested vineyards in the Yarra Valley Region (Victoria, Australia) during 2009 are described.

Biography: Dr Kevin Powell leads the DPI-Victoria phylloxera research program and has over 15 years experience in Hemipteran physiology and management. He coordinated the inaugural International Grapevine Phylloxera Symposium held in Melbourne in 2000. Currently his research focuses on quarantine, detection and post-incursion management of grape phylloxera in Australia. The research team, under his leadership, has focused on the development of novel early detection techniques and scientific validation of quarantine protocols and was awarded the Daniel McAlpine Outstanding Achievement Science Award in 2007 for phylloxera research.

Forecasting spread for rapid response

James Bennett, Michael Renton, *University of Western Australia and CRC for National Plant Biosecurity,* Art Diggle, Fiona Evans, *DAFWA and CRC Plant Biosecurity* and Nancy Schellhorn, *CSIRO Entomology and CRC for National Plant Biosecurity*

Rapid response protocols are essential to minimise the cost of incursion of a new invading pest/disease organism. A key element of a rapid response is an effective surveillance strategy, which relies on the ability to forecast the spread of the organism in the environment in which it was found. Currently, rate of movement is estimated semi-quantitatively, on a case-by-case analysis, to guide containment or eradication programs. These estimates have sometimes been found to be inaccurate after the fact, due to lack of quantification of the way that an organism's characteristics affect its spread.

This project aims to improve the accuracy of spread forecasting by developing a general rapid response system to rapidly summarise the spread characteristics of any new invading pest/disease organism. Instead of splitting species into specific functional groups, our framework will consider a multi-layered functional group approach where each organism is grouped separately for different types of

characteristics (i.e. layers). In the event of an incursion, the new organism will be characterised within each of these layers. The resulting combination of groupings will then form a multi-layer functional characterisation of that organism.

The system will provide a parameterisation for spread models for any invasive organism. I will present the initial prototype design for the multi-layered characterisation system along with some preliminary test output.

Biography: James Bennett completed his PhD in 2008 at the Royal Melbourne Institute of Technology, Melbourne. His background is in applied mathematics. James accepted a CRC for National Plant Biosecurity-funded position at the University of Western Australia as a post doctoral research associate in the School of Plant Biology in April 2009. His current research interests are in improving the accuracy of spread forecasting by developing a general rapid response system to rapidly summarise the spread characteristics of any invading pest/disease organism. Other areas of interest are applied mathematics and statistics; in particular, singular perturbation problems.

Risky business: synthesising expert judgements for environmental risk assessments

Petra Kuhnert and Simon Barry, *CSIRO Mathematical and Information Sciences*

Approaches for synthesising expert judgements elicited from an environmental risk assessment are "risky business". Not only are the experts' responses subject to a range of hidden and unforeseen biases that incorporate different kinds of uncertainty, methods for aggregating, pooling or synthesising expert opinion that account for bias, incorporate dependence between experts and allow for the adjustment of expert responses by way of feedback can make this process a real challenge. Furthermore, the outcome from an analysis of expert opinion can depend quite heavily on the choice of experts, as they often have significant variation in opinions.

We propose a Bayesian hierarchical random effects model that explicitly models the variation between experts, between their responses resulting from feedback and between responses within a given expert to provide (1) a predicted expert interval and (2) a pooled expert response that takes into account various sources of variation attributed to the expert and/or their adjustment to their interval.

This approach provides substantial improvement on existing methods for pooling, such as linear and logarithmic pooling, as it infers a view about the population of experts due to the random nature of the model components, in addition to providing estimates of the variation in the expert opinions to see where the opinion differs. We illustrate the approach using an import risk assessment example.

Biography: Petra is a research statistician in the Environmental Informatics theme within CSIRO Mathematics, Informatics and Statistics and works on a wide range of risk, marine and aquatic ecosystem problems. She has a PhD in applied statistics, focussing more recently on incorporating uncertainty into deterministic models, elicitation practices with experts on risk-related issues and the translation and synthesis of expert opinion into priors to inform Bayesian models.

Atypical BSE and atypical scrapie: a review of risks to human health, animal health and trade

Reg Butler, *Biosecurity Services Group, Australian Department of Agriculture, Fisheries and Forestry*

Atypical bovine spongiform encephalopathy (BSE) and atypical scrapie are among a class of diseases called transmissible spongiform encephalopathies. They are epidemiologically unrelated to each other and have been recognised for less than a decade.

High volume surveillance programs have helped to approximate the incidence of these relatively rare diseases in some countries. Experimental studies indicate that both diseases are possibly sporadic and may not be contagious. If they are sporadic, the incidence of these diseases may be similar in all cattle and sheep populations.

While atypical scrapie is thought to have no food-borne zoonotic consequences, one strain of atypical BSE has shown some zoonotic potential through parenteral experimental studies. Further studies on epidemiology, oral and parenteral challenge and tissue infectivity distribution should help to clarify potential human and animal health risks posed by these diseases.

Most countries have long-standing measures in place to ensure that ruminant meat and bone meal is not fed to ruminant animals. These measures should address potential animal health risks if these diseases are orally infectious, but non-contagious. Existing food safety measures for classical BSE and classical scrapie may address potential human health risks.

Both atypical BSE and atypical scrapie have potential trade consequences for countries that export or import cattle, sheep and their products. In 2009, the World Organisation for Animal Health specifically recognised that atypical scrapie is a separate disease to classical scrapie, but the same decision has not yet been taken for atypical BSE because the risk is less well understood.

The risks that these diseases pose to human health, animal health and trade are not yet fully quantified, but an up-to-date knowledge of their incidence and potential consequences will help inform risk management decisions and risk communication activities.

Biography: Reg Butler is a principal veterinary officer in the Biosecurity Services Group (BSG) within the Australian Government Department of Agriculture Fisheries and Forestry. He manages BSG's One Health Section has been a departmental representative on committees of the Australia's Transmissible Spongiform Encephalopathy Freedom Assurance Program since 2004.

Species traits associated with environmental and economic impact of plant pests

Therese Pluess, *University of Fribourg*, Marc Kenis, *CABI Switzerland*, Marten Winter, *University of Fribourg*, Johan Van Vlaenderen, *CABI Switzerland* and Sven Bacher, *University of Fribourg*

Assessing the future impact of alien plant pests is a major challenge in pest risk analysis. In the present study we look for the first time at species traits associated with impact of alien insect pests. Such traits could be used as predictors for economic and environmental impact in pest risk analysis. We collected data describing environmental and economic impact of plant pests. Environmental and economic impacts were categorised into five categories each and scored for each pest. We hypothesised that two sets of species traits, related to the individual voracity or to high population densities are associated with the overall impact level. While economic impact seems to be related to photosynthetic activity reducers (defoliating and honeydew producing insects), environmental impact is being analysed at the moment. Our findings will be integrated in the pest risk analysis scheme currently being developed in the EU-wide project PRATIQUE (https://secure.csl.gov.uk/pratique/index.cfm).

Biography: Therese completed her undergraduate studies at the University of Bern, Switzerland (2003-2006) and graduated with a Master thesis in landscape ecology in 2007. The topic of the thesis was "Fields in the Desert: Landscape Effects on Spiders in Wheat Fields in the Negev Desert (Israel)". Since 2008 she has been working on her PhD thesis at the University of Fribourg, Switzerland. The thesis is embedded in the EU-funded project PRATIQUE (Enhancements of Pest Risk Analysis Techniques) and is investigating relevant species traits associated with high impact of insect plant pests and common factors of successful plant pest eradication campaigns.

Assessing the robustness of risk maps and survey networks to knowledge gaps about new invasive pest

Denys Yemshanov, *Natural Resources Canada, Canadian Forest Service*, Frank H. Koch, *Department of Forestry and Environmental Resources, North Carolina State University, USDA Forest Service*, Yakov Ben-Haim, *Technion, Israel Institute of Technology, Faculty of Mechanical Engineering* and William D. Smith, *USDA Forest Service*

In pest risk assessment it is frequently necessary to make management decisions regarding emerging pest threats under severe uncertainty. Although risk maps provide useful decision support for invasive species, they often fail to recognise and quantify uncertainties associated with the underlying risk model assumptions or how they may change the risk estimates. Here we apply an information gap concept to evaluate where a pest risk map is "good enough" in the sense that it is robust to uncertainties about a pest's behavior while also providing adequately stable risk estimates. We generate risk maps with a stochastic spatial model of invasion that simulates potential entries of an

invasive pest via international marine cargo shipments, their spread through a landscape and subsequent establishment on a susceptible host resource. In particular, we focus on the question of how much uncertainty in risk model assumptions can be tolerated before the risk map loses its value. The approach is illustrated with an example of a forest pest recently detected in North America, *Sirex noctilio* Fabricius. The results provide a spatial representation of the robustness of predictions of *S. noctilio* invasion risk to uncertainty and show major geographic hotspots where the consideration of uncertainty in model parameters changes management choices of survey and monitoring strategies for a new invasive pest. We then use the trade-offs between the extent of uncertainties and the degree of robustness of a risk map to select a survey network design that is most robust to knowledge gaps about the pest.

Biography: Dr. Yemshanov joined the Natural Resources Canada in 2002. At the Canadian Forest Service his research specialisation can be described as development and integration of spatial modeling applications focused on various ecological and bioeconomic aspects of forest resources. Areas of his special interest include the development of integrated bioeconomic impact models and risk mapping/modeling techniques for forest invasive species. Other research activities include the bioeconomic modeling of carbon sequestration and offset policies and related land-use dynamics in Canada. Dr. Yemshanov received his PhD in ecology from the University of Dniepropetrovsk, Ukraine.

Assessing spatial patterns of disease risk to biodiversity: implications for the management of the amphibian pathogen, *Batrachochytrium dendrobatidis*

Kris A. Murray, *The Ecology Centre, School of Integrative Biology, University of Queensland*. Richard W. R. Retallick, *GHD Pty Ltd*, Robert Puschendorf, *School of Marine and Tropical Biology, Centre for Tropical Biodiversity and Climate Change Research, James Cook University*, Lee F. Skerratt, *School of Public Health, Tropical Medicine and Rehabilitation Sciences and the Amphibian Disease Ecology Group, James Cook University*, Dan Rosauer, *School of Biological, Earth and Environmental Sciences, University of New South Wales and Centre for Plant Biodiversity Research,* Hamish I. McCallum, *School of Zoology, University of Tasmania*, Lee Berger, *School of Public Health, Tropical Medicine and Rehabilitation Sciences and the Amphibian Disease Ecology Group, James Cook University*, Rick Speare, *School of Public Health, Tropical Medicine and Rehabilitation Sciences and the Amphibian Disease Ecology Group, James Cook University* and Jeremy VanDerWal, *School of Marine and Tropical Biology, Centre for Tropical Biodiversity and Climate Change Research, James Cook University*

Emerging infectious diseases can have serious consequences for wildlife populations, ecosystem structure and biodiversity. Predicting the spatial patterns and potential impacts of diseases in free-ranging wildlife is therefore important for planning, prioritising and implementing research and management actions. In this study, we developed spatial models of environmental suitability (ES) for infection with the invasive pathogen *Batrachochytrium dendrobatidis*, which causes the most significant disease affecting vertebrate biodiversity on record: amphibian chytridiomycosis. We applied relatively newly developed methods for modelling ES (Maxent) to the first comprehensive, continent-wide database (comprising >10000 observations) on the occurrence of infection with this pathogen and employed novel methodologies to deal with common but rarely addressed sources of model uncertainty. We used ES to 1) predict the minimum potential geographic distribution of infection with *B. dendrobatidis* in Australia and 2) test the hypothesis that ES should broadly translate to an index of disease risk to susceptible amphibian hosts given its theoretical and empirical link with organism abundance (intensity of infection), a known determinant of disease severity. We show that 1) infection with *B. dendrobatidis* has likely reached its broad geographic limits Australia-wide under current climatic conditions but smaller areas of invasion potential remain, and 2) that high ES values accurately predict areas where population declines due to severe chytridiomycosis have occurred. We thus derived a “mean disease risk” index for all Australian amphibians and demonstrated that extinct and declining species experience significantly higher mean disease risk than stable species at a continental scale. Given scarce conservation resources, our results can be used immediately in Australia and our methods applied elsewhere to prioritise species, regions and actions in the struggle to limit further biodiversity loss.

Biography: Kris has recently written up his PhD thesis on the ecology and distribution of the amphibian chytrid fungus. His research interests include evolutionary ecology, parasitology, wildlife diseases and conservation biology.

Can we build better spatial temporal models of pest insect incursions? A trial using TOPS

John Weiss, *Cooperative Research Centre for National Plant Biosecurity, Department of Primary Industries and School of Botany, Melbourne University*, Michael McCarthy, *School of Botany, Melbourne University* and Simon McKirdy, *Cooperative Research Centre for National Plant Biosecurity*

Management of incursions of insect plant pests requires not just the knowledge of where the pests presently are, but where and how far they could move. All insects move to some extent; the distance they move depends upon the species, the stage in its life cycle and the reason for its movement. Movement could range from a few centimetres to find a better food source to mass movements over hundreds or thousands of kilometres. How insects move through the landscape and where they can be found is important in developing a control strategy for the pest. Insects have the ability to find and select particular hosts and by understanding how they do this, effective targeted management actions can be implemented.

Certain insect species rely heavily on visual cues to locate and select particular host plants. Insects may differentiate stressed or actively growing plants by their spectral reflectance. A daily host suitability model based upon plant's photosynthetic activity, as determined by spectral reflectance or absorption, could then indicate where insect pests are located. By then combining this measure of suitability with a pest's biology, simulations could forecast or predict pest outbreaks and identify feasible and effective containment or management options.

By using NASA's Terrestrial Observation Prediction System - Gross Primary Production model (TOPS GPP) to model daily photosynthetic rates of vegetation types for southeastern Australia, we hope to measure their suitability to particular pests.

We plan to compare the TOPS predictive pest dispersal model with models run on a static landuse layer to determine which has better predictive power. The Queensland fruit fly, the Australian plague locust and the currant lettuce aphid will be piloted, with the project aiming to produce a more generic template model for other pests.

Biography: John Weiss is a PhD student with the CRC for National Plant Biosecurity and the Victorian Department of Primary Industries. He has been working on and researching invasive species for nearly 20 years. He investigated the biological control and integrated management of the invasive weed Horehound for 9 years, and more recently worked on weed risk analysis and predictive modelling of potential weed impacts. At present he is enjoying working with NASA to see if we can use dynamic environmental layers to improve predictions for pest incursions.

Are scavenging ducks a biosecurity risk for HPAI spread and infection?

Joanne Meers, Joerg Henning, Kate Henning, Hendra Wimbawa, *University Of Queensland* and Le Tri Vu, *Regional Animal Health Centre, Ho Chi Minh City*

Highly pathogenic avian influenza (HPAI) H5N1 virus has been causing outbreaks of disease in poultry and deaths in humans since 2003. Indonesia and Vietnam are two of the countries most severely affected by H5N1 HPAI in terms of both human and poultry health. Despite the control measures introduced in these countries, cases of HPAI infection continue to occur in people and poultry. A research project was established in 2006 to investigate the proposed role of ducks as maintenance hosts for H5N1 infection. Longitudinal studies were conducted in both countries to examine the patterns of infection on small-scale commercial and backyard duck farms. In Indonesia, investigations were conducted in Central Java while in Vietnam the Mekong Delta was the focus of the research. From early 2007, these farms were monitored in regular intervals over prolonged periods, with ducks and in-contact chickens sampled from each farm. Questionnaires were used to collect information on changes in flock structure, husbandry practices, marketing, health status of ducks, HPAI outbreaks and flock vaccination status. Blood samples and swabs were collected from the individually identified birds and tested for the presence of H5 antibodies or virus, respectively. Results presented from these longitudinal studies will elucidate the role played by ducks in the maintenance and transmission of H5N1 virus. In addition, case-control studies were also conducted in Vietnam to identify flock-level and commune-level risk factors associated with the HPAI outbreaks that occurred from December 2006 to January 2007 in the Mekong Delta region. This work will help to better understand the epidemiology of

the disease in ducks and assist policy makers in developing improved HPAI control measures and surveillance strategies. Monitoring infection in ducks may help to reduce the risk of virus transmission to other poultry species and to humans.

Biography: Joanne Meers is an Associate Professor of veterinary virology at the University of Queensland. She has been the leader of a number of research projects on animal diseases in southeast Asia funded by the Australian Centre for International Agricultural Research. Her other research interests include viral diseases of Australian wildlife species.

Risk analysis of virulent Newcastle disease associated with small landholders in Queensland, Australia

Nina Y. Kung, Karen Skelton, Sandy MacKenzie, David Pitt, *Queensland Primary Industries and Fisheries* and Tony Martin, *Department of Agriculture and Food, Western Australia*

Australia is free from virulent Newcastle disease (ND). Exotic virulent ND has only been introduced twice into Australia (in 1930 and 1932) and both incursions were eradicated by a slaughter-out response. Between 1998 and 2002, there were several sporadic outbreaks in New South Wales and Victoria. Evidence suggests that these outbreaks may have been due to the mutation of avirulent strains that are endemic in the poultry industry in all states and also in a number of species of wild birds. Australian federal and state governments have been working closely with the poultry industry on ND surveillance and on-farm biosecurity. However, the numbers of "lifestyle" farmers/small landholders have increased significantly in recent years, especially in some areas of southeast Queensland, which is also the predominant commercial poultry production area for the state. The numbers and species of poultry that are kept on the small landholdings, together with the husbandry and on-farm biosecurity practices of these "hobby farmers", have led to the perception that these small landholders pose a biosecurity threat in relation to the introduction, establishment and spread of virulent ND to the mainstream poultry industry in Australia.

This paper addresses the potential risks of virulent ND (either an exotic strain or a mutated avirulent strain) associated with small landholders in Queensland. Data collected includes the location and flock sizes of small landholders and commercial producers and their biosecurity practices. Questionnaires were mailed to small landholders and commercial producers and results used in a quantitative risk assessment. This risk analysis also identifies potential risk mitigation measures for virulent ND. Outcomes from this project could be used to inform policy decisions on prioritisation and resource allocation in the area of poultry biosecurity and small landholder engagement.

Biography: Nina gained her MSc at James Cook University and second BVSc at Massey University. She worked for New Zealand MAF in the food safety division as auditor/HACCP specialist after graduation. Her PhD was on the "Epidemiology of avian influenza viruses in Hong Kong" where she conducted studies in the poultry sector assisting the Hong Kong Government with avian influenza control/prevention strategies. Before settling in Brisbane Nina was employed as Operations Manager in a veterinary diagnostic serology and food microbiology testing laboratory. Nina started with QPIF in Sep 2007 (days after the equine influenza outbreak) and has worked extensively in disease response/eradication, notably in the equine influenza and Hendra outbreaks.

Optimised sampling, processing and testing for enhanced detection and characterisation of Avian Influenza Virus from field samples

Simone Warner, Kim O'Riley and Mark Fegan, *Department of Primary Industries Victoria*

Avian influenza (AI) is of worldwide significance due to the widespread infection of production and wild birds. All birds are believed to be susceptible to AI, but migratory waterfowl and other aquatic birds can carry the virus (AIV) without disease symptoms. Given the migratory nature of birds, and the reservoir of AIV that these populations represent, we sought to identify and understand the range of AIV genotypes circulating in Victoria. Targeted surveillance of wild birds and ducks has been conducted for the last six years. To date, more than 12000 wild birds have been sampled in Victoria and screened utilising the DPI Type A PCR test that detects all AIV subtypes. In addition, a new subtyping PCR has

been developed that is finally allowing the characterisation of the majority of AIV Type A positive samples.

A critical aspect of disease surveillance is the collection and storage of good clinical specimens. This is particularly important for the diagnosis of an exotic or emergency disease such as AI. The introduction of molecular-based tests has significantly increased the detection of viruses in field samples; however, virus cannot always be grown to confirm the result. We investigated various sampling procedures for enhanced detection of live virus from field samples, and assayed by egg culture and by PCR. Further to this, the time delay between collection of field samples and processing by PCR was assessed using DPI's diagnostic van, a mobile laboratory fitted with equipment. Freshly collected samples were assayed for AIV genetic material in the field utilising the diagnostic van, and also at the laboratory.

This work has led to the optimisation of media and storage procedures for enhanced detection and culture of AIV, as well as the development of molecular-based tests optimised for the detection and haemagglutinin subtyping characterisation of AIV.

Biography: Dr Warner has been working as a microbiologist for the past 20 years, and currently works for the Department of Primary Industries, Victoria. In the role as Statewide Leader for Microbiology, Dr Warner leads a group of almost 60 people in various areas of veterinary and plant bacterial and viral research, particularly in the area of biosecurity. Over the last 6 years, Dr Warner has specifically developed an interest in avian influenza, molecular diagnostic test development and is a member of the National avian influenza surveillance steering committee.

Development of a bead-based assay for simultaneous detection of equine respiratory viruses

Ximena Tolosa, Bruce Corney, *Australian Biosecurity CRC for Emerging Infectious Disease and DEEDI, Biosecurity Queensland*, Victoria Boyd, Hans Heine, *CSIRO Livestock Industries*, *Australian Animal Health Laboratory*, Ibrahim Diallo, *DEEDI, Biosecurity Queensland*, Paul Campbell, Andrew Geering, *DEEDI, Horticulture and Forestry Science* and Bronwyn Battersby, *Nanomics BioSystems Pty. Ltd.*

Viral respiratory diseases are among the most economically important diseases in horses. Simultaneous detection of some of the viruses responsible for respiratory disease in horses such as equine influenza virus and equine herpesviruses can be achieved by the use of multiplex suspension arrays. The aim of this work was to develop a suspension array for rapid differential diagnosis of viral respiratory disease in horses in a single test. The suspension array allowed rapid detection of viral nucleic acid sequences extracted from nasal swabs. Luminex xTAG technology was used to detect influenza virus A (generic influenza assay), equine influenza virus, equine herpesvirus 1, equine herpesvirus 2, equine herpesvirus 4 and equine herpesvirus 5. The three major steps involved in performing the suspension array were 1) amplification and labelling of nucleic acid obtained from nasal swab sample; 2) hybridisation of labelled viral sequence to xTAG beads and 3) detection of viral sequence using flow cytometry instrumentation. With further optimisation and validation, the suspension array could be useful for the rapid and simultaneous detection of the most important DNA and RNA viruses that cause respiratory infections in horses. Specificity and repeatability of the assays was demonstrated. This technology also offers great potential for use in other disease syndromes in other animal species.

Biography: Ximena Tolosa is postdoctoral researcher. Her work focuses is on the application of suspension arrays for multiplex detection of respiratory viruses endemic to Queensland horses. This work was supported by the Animal Biosecurity CRC.

Beyond ELISA: high throughput plant virus detection via multiplexed bead-based immunoassays

Jill Meldrum, *Nanomics BioSystems Pty Ltd,* Kathleen Parmenter, Andrew Geering, *Cooperative Research Centre for National Plant Biosecurity and Queensland Primary Industries and Fisheries* and Bronwyn Battersby, *Nanomics BioSystems Pty Ltd*

Plant viruses pose a significant economic and biosecurity threat to Australia's agricultural industries. Current diagnostics range from symptom-based analysis to nucleic acid assays and enzyme-linked immunosorbent assay (ELISA) detection. Whilst ELISA is routinely used, it involves many handling steps and is limited to a single virus per test. We describe the next generation of ELISA-like diagnostics, an OptoPlex™ bead-based immunoassay system for high throughput multiplexed screening for viruses in plant tissue. Three economically important potato viruses, potato virus Y, potato leafroll virus and potato virus X, are regularly tested as part of certified potato seed schemes. An assay was developed to test for the three viruses in multiplex using the OptoPlex™ system. The detection limits for all three viruses were equivalent to that of single virus ELISA and reduced processing time, handling and reagent quantities. Work is continuing to broaden the assay to include more viruses in the Solanaceae and to target other commercially important crops, such as tomato.

Biography: Jill Meldrum is a postdoctoral research fellow at Nanomics BioSystems Pty Ltd based at the Australian Institute of Bioengineering and Nanotechnology (AIBN) at the University of Queensland. Her current research interests include the development and commercialisation of high throughput bead-based assays for virus and protein biomarker detection using antibodies and antibody-like molecules.

Can we use CSI methods to detect fungal spores on clothing?

Dominie Wright, *Department of Agriculture and Food, Western Australia and Cooperative Research Centre for National Plant Biosecurity*, David Berryman, *Cooperative Research Centre for National Plant Biosecurity and Murdoch University*, MingPei You and Belinda Cox, *Department of Agriculture and Food, Western Australia and Cooperative Research Centre for National Plant Biosecurity*

Picture this: Crime scene investigators walking into a room, using tape and small vacuum cleaners to collect evidence to convict the perpetrator. On television shows like CSI, this evidence is bagged and then taken to a lab where it is processed, and inevitably there is a machine that goes "ping" saying that the results are ready. Can we do this in the world of plant pathology? Do we need to do this? Why would we do this?

This project is investigating the use of different CSI methods to determine the risk of spores entering Australia on travellers' clothing. The use of forensic lift off tape is being assessed for its ability and sensitivity in collecting spores that maybe present on clothing. Leaf rust (*Puccinia triticina*), stem rust (*Puccinia graminis* f.sp. *tritici*) and stripe rust (*Puccinia striiformis* f. sp. *tritici*) of wheat are the model pathogens being used that can pose a risk to the agricultural sector of Australia.

Under some conditions, clothes collect spores and transfer them. However, the size of the fibres and the weave of the material may influence the effectiveness in collection and transfer of spores. The decontamination of clothing is an important aspect to consider after being in a field with diseases and this will also be investigated.

Preliminary results in assessing the tape and the transfer of spores on clothing will be presented along with initial investigations in the use of mass spectrometry and real-time PCR to determine if these technologies are suitable for identification of the spores.

The project will provide data on the risk of spores travelling on clothing and the necessary strategies required to ensure that this risk is reduced when returning from field trips locally, nationally and internationally. It will also highlight the responsibility that must be shared when protecting Australia's agriculture and environment.

Biography: Ms Dominie Wright is a plant pathologist with the Department of Agriculture and Food, Western Australia. She has a broad background in plant pathology, having worked in both the broadacre and vegetable sectors as a diagnostician for fungal and bacterial pathogens. Dominie has a strong interest in biosecurity, having developed a national diagnostic protocol for *Tilletia indica,* and she is currently preparing the international protocol for IPPC. She has also developed with colleagues two national contingency plans for *T. indica* and *T. contraversa*. Dominie is excited to be investigating the use of forensic methods for plant pathology.

Hyperspectral imagery for plant pest recognition

Pattaraporn Khuwuthyakorn, *Cooperative Research Centre for National Plant Biosecurity, National ICT Australia (NICTA) and RSISE, Australian National University*, Dr Antonio Robles-Kelly, *NICTA and RSISE, Australian National University* and Dr Jun Zhou, *(NICTA and RSISE, Australian National University*

Spectral signatures have been used by scientists for over 100 years to identity materials and their composition. As hyperspectral sensors become cheaper and more practical, hyperspectral imaging has been used in a broader range of areas beyond remote-sensing applications. More recently, hyperspectral imaging has emerged as a new technology that can employ multi-dimensional spectral signatures to perform pest recognition. This hinges on the notion that different pests have different characteristic responses as functions of wavelength, which provide a unique description of the insects under study. This enables detection and classification of pests into relatively narrow categories. In this paper, we focus on the use of hyperspectral imaging for purposes of plant pest recognition, making use of high-dimensional spectral-texture information. We use hyperspectral signatures in images to generate a description that is based upon Fourier analysis. Our descriptor has a high information compaction property and can capture the space and wavelength correlation for the spectra in the images under study. This permits capturing the structural features of the plant pests of interest. In the experiment section, we illustrate the utility of our method for plant pest recognition and provide results on an oriental fruit moth image dataset.

Biography: Pattaraporn Khuwuthyakorn is a second-year PhD student under the Education and Training Program of the CRC for National Plant Biosecurity. She is working on project CRC60075: NICTA Smart Trap, which is a joint project between NICTA and the CRC. Patt's research interests are in the areas of pattern recognition, computer vision, and spectral imaging and especially in their applications. At present, Patt is studying at the Australian National University, Canberra, Australia, under the supervision of Dr Antonio Robles-Kelly, Dr Jun Zhou and Dr Louise Morin (CSIRO Entomology).

Systematics of the Macropsinae (Hemiptera: Cicadellidae) leafhoppers of Australia

Linda Semeraro, *Cooperative Research Centre for National Plant Biosecurity and Department of Primary Industries Victoria*, Murray Fletcher and Andrew Mitchell, *Industry & Investment NSW*

Fundamental to building a capability for the detection and identification of emergency plant pests is a sound taxonomic understanding of the native fauna, particularly of those taxa that are closely related to exotic pest species. Leafhoppers (Insecta: Hemiptera) are phytophagous and can be serious economic plant pests, damaging plants through direct feeding and through their ability to vector plant diseases.

This project addresses the Australian fauna of the leafhopper subfamily Macropsinae. This subfamily has received little taxonomic attention in Australia which, in part, reflects the taxonomic complexity of the group.

At least four macropsine species (in the genera *Macropsis* and *Oncopsis*) are known to transmit phytoplasma diseases overseas. These two genera are the largest in the subfamily and have a predominantly northern hemisphere distribution, although have been used for a number of Australian species.

In current literature, there are 46 species and nine genera of macropsines known to occur in Australia. At least half of those species have been tentatively placed within the holdall genus *Macropsis*.

The objectives of this study are to (1) clarify which macropsine genera are represented in Australia and (2) determine whether the Australian fauna contains representatives of *Macropsis* and/ or *Oncopsis*. The relationship between Australian and exotic species of macropsines, particularly pest species known overseas, is investigated.

The revision of Australian macropsine genera is based on a combined approach of examining morphological taxonomic characters and molecular DNA sequences (including one mitochondrial gene and one nuclear gene). Further discussion of project methods and results will be presented.

Biography: Linda is a PhD student with the CRC for National Plant Biosecurity, enrolled at LaTrobe University (Bundoora), Victoria, Australia and based at DPI Victoria, Knoxfield, Australia, where she has been working for over 9 and a half years (full-time 2000 – 2008, part-time 2008 – to present) in the Victorian Agricultural Insect Collection. Her interest is in taxonomy and systematics, particularly of leafhopper insects.

Drivers Stream Abstracts

(in presentation order)

Comprehensive bioeconomic modelling of the risk management of multiple non-indigenous harmful species: to exclude, or to wait and control?

Roman Carrasco; *Department of Statistics & Applied Probability, National University of Singapore and Centre for Environmental Policy, Imperial College London*, A. MacLeod; *The Food and Environment Research Agency*, J.D Knight; *Centre for Environmental Policy, Imperial College London*, R. Baker; *The Food and Environment Research Agency* and J.D. Mumford, *Centre for Environmental Policy, Imperial College London*

Non-indigenous harmful species (NIS) introductions lead to loss of biodiversity and serious economic impacts. National Plant Protection Organisations have to decide on the allocation of resources to manage the risk posed by multiple NIS. Bioeconomic modelling has focused on single species and little is known about the optimal management of multiple NIS. A comprehensive bioeconomic model that considers the exclusion, detection and control of multiple NIS spreading by stratified diffusion was developed and applied to manage the simultaneous risk posed by Colorado beetle, the bacterium causing potato ring rot and western corn rootworm in the UK. We show analytically that cost-effective management resources allocation should follow a principle of equimarginality by which the marginal avoided costs of each management activity and NIS should equal the marginal costs of that activity. We incorporate uncertainty and used a genetic-algorithm combined with Monte-Carlo simulation to demonstrate that exclusion measures are not necessarily the most cost-effective option and that the consideration of NIS assemblages increases management efficiency. The adoption of costly management measures based on the pest risk analysis of a single NIS might not correspond to the optimal allocation of resources when other NIS easily controlled are considered. We identify comprehensive bioeconomic modelling of multiple NIS as a transparent way to justify plant health risk management actions, thus contributing to fair international trade.

Biography: Roman Carrasco completed his PhD in Autumn 2009 in Quantitative Modeling for Pest Risk Analysis at Imperial College London (UK) under the supervision of Prof. John Mumford, Dr. Jon Knight, Dr. Richard Baker (FERA, UK) and Dr. Alan Macleod (FERA, UK). Roman developed optimal control and agent-based models to assist plant health decision-making by UK biosecurity authorities. Currently, Roman is a research fellow of the National University of Singapore under the supervision of Dr. Alex Cook. His research focuses on developing mathematical and statistical methods to model the spread and control of infectious diseases.

Rethinking biosecurity policy interventions: use of network analysis

David Newth and Don Gunasekera, *CSIRO Complex Systems Science*

Global biosecurity risks are influenced by factors such as trade in goods and passenger travel; transport vectors (vessels and containers); and natural spread (climate and weather effects). The biosecurity risks associated with these factors are expected to increase with expansion in supply, demand and trade in livestock products driven by income and population growth and changing dietary patterns, particularly in rapidly growing developing countries. In identifying and managing such risks, it is more efficient and effective to use proactive and sustainable policy interventions rather than reactive measures. In this presentation, we illustrate the applicability of the EpiCast (Epidemic foreCast) framework as a decision support tool to assist policy makers in formulating agricultural biosecurity risk identification, management and intervention regimes. EpiCast is a high resolution individual based simulation model underpinned by social network theory. It takes a 'whole of population' approach to modelling the spread of emerging diseases and pests. We highlight the usefulness of EpiCast modelling and analysis in providing valuable input into focussing biosecurity efforts on those areas that will provide the greatest reduction to potential threats-be it disease or pest; natural or human induced- in a cost effective manner.

Biography: Don Gunasekera is a Visiting Scientist at the CSIRO Centre for Complex Systems Science. Previously he was the Chief Economist at ABARE. He has an ANU PhD. in Economics and has completed Harvard University Senior Managers in Government Program. Don has worked on the socio-economic impacts of influenza and integrated assessment modelling.

David Newth is a Research Scientist at the CSIRO Centre for Complex Systems Science. He was the first PhD graduate in complex systems from Charles Sturt University and went on to win the Vice

Chancellor's award for research excellence. In 2008, he was awarded the CSIRO's John Philip Science Medal. His research interests include: complex systems, integrated assessment modelling, agent based modelling, network analysis and human behaviour.

Using an ecological-economic model to quantify and communicate bio-invasion uncertainty in deliberative multi-criteria evaluation

Shuang Liu, *CSIRO Entomology* and *Cooperative Research Centre for National Plant Biosecurity*, David C. Cook, *CSIRO Entomology, Cooperative Research Centre for National Plant Biosecurity and The Australian National University, Fenner School for Environment and Society,* Art Diggle, Abu-Baker M Siddique, *Department of Agriculture and Food - Western Australia and Cooperative Research Centre for National Plant Biosecurity*, Kim E. Lowel and Michael Hurley, *Department of Primary Industries Victoria and Cooperative Research Centre for National Plant Biosecurity*

A *STELLA* model was developed to capture the dynamics of the socio-ecological system of bio-invasion and to assess the expected economic cost of agricultural invaders over the next 30 years for Australia. The model cannot be meaningfully calibrated because it simulates a never-before-experienced state of the system. Therefore, it is inappropriate to apply generic calibration techniques to forecast the invasion cost. Instead of forecasting, a more proper use is as a communication tool for uncertainty, which presents "what if" scenarios to the stakeholders in a Deliberative Multi-criteria Evaluation (DMCE) environment.

In order to demonstrate the uncertainty associated with the estimation of expected market costs, we presented two scenarios: business-as-usual *vs*. double-trouble, where we assumed that the inspection budget was insufficient prior to invasion and that also the invaders would spread faster. The DMCE participants were asked to weight their criteria twice, before and after the uncertainty was reported and discussed. The effectiveness of the model as a communication tool was examined by comparing the average group weights and the standard deviation of the individual weights in the two rounds.

The results showed that the standard deviation in the sub-group without a scientific background increased significantly. This change resulted from an increased difference in the individual weights, which indicated that uncertainty acted as a barrier for forming group consensus.

Our ecological-economic modeling offers a systematic and more objective way of organizing data and synthesizing knowledge. The DMCE allows a participatory decision-making process with active involvement and commitment from the participants. The integrated modelling–DMCE approach seeks to combine the advantages of both these approaches. This integrated approach provides a promising method to quantify and communicate bioinvasion uncertainty to stakeholders.

Biography: Shuang received her BA in biology and MSc. in ecology from Nankai University, China. In 2007 she completed her PhD in University of Vermont, USA on valuing ecosystem services using environmental economic techniques. In the same year she took up a post-doc position and has been since working for CSIRO Entomology and CRC for National Plant Biosecurity in Canberra.

Decision making under uncertainty with application to biosecurity

Rob Reeves and Aaron Thrift, *Queensland University of Technology*

Import Risk Assessment (IRA) methodologies identify significant pests or diseases relevant to an import proposal, assess the risks they pose, and specify measures to reduce unacceptable risks. When the likelihood of entry, establishment and spread for these pests or diseases is small, it makes performance assessment of IRA methodologies difficult in real time. Consequences are potentially high making assessment of importation decisions necessary. This research assesses the performance of a simplified decision making methodology, such as that used in recent IRA's, through stochastic simulation. Various importation scenarios simulate parameter uncertainty and emphasize weaknesses inthe methodology. The robustness of decisions made under a simplified decision making methodology are assessed against simulated data. The actual losses are simulated, given that a simplified decision making methodology allows importation. The decision making methodology is evaluated by assessing simulated losses under various scenarios of differing pest numbers and stochastic and epistemic

variability. It is found that the methodology may inadequately represent quarantine risk because of a piecemeal assessment of each pest in isolation, and may inadequately represent the risk associated with increasing stochastic and epistemic variability.

Biography: Dr Rob Reeves has provided methodological reviews of recent Pest Risk Assessments for the Australian Banana Growers Council Inc, and Apple and Pear Australia. He teaches and researches in Bayesian statistics at the Queensland University of Technology.

A participatory approach to prioritizing plant pests and diseases

David C. Cook, *CSIRO Entomology*, *Cooperative Research Centre for National Plant Biosecurity and The Australian National University, Fenner School for Environment and Society,* Shuang Liu, *CSIRO Entomology and Cooperative Research Centre for National Plant Biosecurity*, Abu-Baker M Siddique, Art Diggle, *Department of Agriculture and Food - Western Australia and Cooperative Research Centre for National Plant Biosecurity*, Michael Hurley and Kim E Lowell, *Department of Primary Industries Victoria and Cooperative Research Centre for National Plant Biosecurity*

The implications of uncertain information concerning future threats to Australia's plant industries have not been discussed in a risk management context. This is largely due to that fact that profound uncertainty and even ignorance characterizes states of scientific knowledge about invasive species risks, thus preventing comprehensive use of quantitative simulation models. Moreover, the changing context in which invasive species management and planning decisions must be made is constantly changing. In this paper we discuss an adaptable methodology that is helping Australian horticultural industries to manage their biosecurity risks in spite of this uncertainty problem. By combining bioeconomic impact simulation models and interactive decision facilitation tools, we demonstrate how industry groups can clearly and transparently identify the highest priority threats their industries, and how future incursions might be managed. This information can then be embedded within industry development and research and development strategies for the future. We present results of an exotic pest prioritization exercises recently conducted with several industries in which the extent of scientific knowledge about individual pest threats was conveyed to a stakeholder jury. We find that the level of scientific uncertainty does not necessarily affect group prioritization results, and should not be considered a barrier to quantitative risk modelling.

Biography: David hails from the Great Southern region of Western Australia. He completed a Bachelor of Economics degree at Murdoch University in 1995, and from 1996-2004 worked as a Regional Economist with the Western Australian Department of Agriculture investigating invasive species issues. During this period David completed a PhD with The University of Western Australia's School of Agricultural and Resource Economics (1999-2001), and worked as a postdoctoral research assistant at Imperial College London (2003-2004). In 2005 he took up a Research Economist position with CSIRO Entomology in Canberra, and an adjunct appointment with the Australian National University's Fenner School of Environment and Society

If biological invasions are spatially and temporally explicit, why isn't biosecurity risk analysis?

Brendan Murphy, Paul De Barro and Darren Kriticos, *CSIRO Entomology and Cooperative Research Centre for National Plant Biosecurity*

Australia undertakes Import Risk Analysis (IRA) to determine the phytosanitary risks associated with trade commodities. In order to first demonstrate absence and then estimate probabilities of entry, establishment, spread and impact for potentially thousands of exotic plant pests not currently in Australia, spatial layers are required describing the distributions of existing pests, surveillance and response effort, trade points of entry (pathways), commodity movements (end use, waste points), transport networks, geographic barriers to spread, soils, climate, host vegetation layers, etc. Because of the often substantial lag between incursion and detection, the ability to attribute an incursion to a particular trade event (assuming this was the cause) also requires such data to be time-stamped. This does not currently occur, and we argue that capturing such data layers in a spatial database platform would provide a more robust, rapid and consistent approach to risk

analysis with other distinct benefits. For example, climate matching, population dynamics, economic impact and post-detection hindcast models could be vertically integrated and tested under different scale/time scenarios or using real time data, and surveillance and response activities benefit from improved spatial understanding of risk. Information can be considered a limiting factor to risk analysis, so data capture, gaps, value, flow (including feedback loops) and sensitivity can be modelled by abandoning the traditional biosecurity 'continuum' (pre-border, border, post border) and applying network theory to 'real' biosecurity nodes (e.g. pre-border, border, surveillance, response, diagnostics, risk analysis). Although the feasibility and limits to such an approach need further exploration, it offers a potentially elegant solution to the Beale Review conundrum in Australia where improved biosecurity data capture and management was recommended, but it was not indicated how this might be achieved or where effort should be apportioned.

Biography: Brendan's research background is in forest health including a PhD on biocontrol of chrysomelid pests of *Eucalyptus* and *Acacia* in New Zealand. He subsequently spent three years with the New Zealand Ministry of Agriculture and Forestry developing the national forest biosecurity surveillance strategy, included designing and managing the High Risk Site Surveillance (HRSS) and gypsy moth surveillance programmes. Following contracts with a state owned enterprise, Brendan accepted a post-doctoral position with CSIRO Entomology in Australia in 2008 where he currently works in phytosanitary risk analysis.

Incorporating uncertainty into import risk assessments: a Bayesian Melding approach

Petra Kuhnert and Simon Barry, *CSIRO Mathematical and Information Sciences*

A well established result in import risk assessments is the equation, $I = 1 - (1 - p)^N$, which defines the overall probability of an incursion *I*, via a geometric distribution that takes into account the time or amount of material arriving from an overseas destination, *N* and the overall probability that the event occurs, *p* given the sequence of events that led to the invasion. Typically there is little or no data on each of the inputs *p* and *N* as well as the output *I*. As a result, a range of techniques are often used to elicit prior probability distributions from a range of experts for each of these parameters.

The evaluation of I can be a real challenge. The expert opinion elicited about each parameter can be biased, the opinions can vary depending on the choice of experts and the elicitation of *p* can be poorly conditioned. Furthermore, the evaluation of the right hand side of the equation may be quite different to the result obtained on the left hand side using elicitation techniques.

We propose an approach which makes use of the expert opinion on the inputs and outputs of the incursion equation using an application of Bayesian Melding. The advantage of this approach is its ability to incorporate uncertainty in the inputs and outputs such that, if the expert inputs and outputs are inconsistent, this will be conveyed by a non-informative posterior distribution for each parameter. This represents an advance in risk research because existing methods ignore information on I and therefore ignore the potential dependence or lack thereof associated with the responses to the inputs and outputs. This approach has the ability to pin-point issues in the elicitation approach undertaken to evaluate risk and has the potential to highlight conditioning problems incurred through the evaluation of p.

Biography: Petra is a research statistician in the Environmental Informatics theme within CSIRO Mathematics, Informatics and Statistics and works on a wide range of risk, marine and aquatic ecosystem problems. She has a PhD in applied statistics, focussing more recently on incorporating uncertainty into deterministic models, elicitation practices with experts on risk related issues and the translation and synthesis of expert opinion into priors to inform Bayesian models.

Policy and legal framework for managing biosecurity (Indonesian perspective)

Theofransus Litaay, *Satya Wacana Christian University*

It is widely acknowledged that the world has become 'smaller'; borders between nation states are no longer seen as separators but more as boundaries of different identities of groups who communicate with each other. Direct communication between individual regions in different countries is frequent,

even when communication between those same countries may be less frequent. Advancements in transport technologies have increased the movement of people and goods from one region to another. This movement brings along with it positive outcomes, such as trading in/sharing goods, information and services, but also negatives such as the introduction of viruses, pests and diseases. The latter, of course, marks out the focus of this book's chapter, which is on the policy and legal frameworks under which biosecurity currently rests. However, while policy and legal frameworks are potential facilitators of or impediments to national and international effective biosecurity, it is presently not understood what these are, who the originating bodies are, nor how policies at national, regional and local levels mesh (or not) to produce effective biosecurity management. This implies that effective management of biosecurity lies in the hands of many players: international, national and local. This chapter provides an introduction to existing policy and legal frameworks for biosecurity that presently impinge (or should, or might), and finishes by outlining some of the key issues that are suggested by theseinfluences. The international framework starts with a discussion about the FAO Biosecurity toolkit regarding policy and strategy making in regards integrated national biosecurity policymaking. It continues with the UN Convention on Biodiversity which sets down some principles of engagement for policy sectors at all levels, while also providing guidelines for how they should work with local communities who in turn possess local knowledge that in many cases has effectively managed biosecurity in those regions. The guiding question addressed in the chapter is, 'What are the prevailing international, national, and local policy and legal frameworks impacting on effective management of biosecurity?' Related to this question is the practical question of what can be done to improve the effectiveness of biosecurity management using these frameworks? The findings, including the need for improved local government capacity in dealing with international policy frameworks, suggest the need for a new development paradigm.

Keywords: Policy, Biosecurity, Local knowledge.

Biography: Theofransus Litaay finished undergraduate degree at SWCU law school in Indonesia and finished his master of laws degree at Vrije University in Amsterdam. He is a lecturer of Staya Wacana Christian University (SWCU) and researcher at the Centre of Eastern Indonesia Studies SWCU in Salatiga, Central Java. Since 2007, he join the Australian – Indonesian Biosecurity Community Management Project (Ausindo-Biocom), a project of CRC – Plant Biosecurity conducted by Charles Darwin University and Indonesia universities such as SWCU, Mahasaraswati University Denpasar, Nusa Cendana University Kupang, etc. since 2008, he started his PhD study at Charles Darwin University. This research analyse the existing policy and legal frameworks of biosecurity – related areas in Indonesia and the possible development for the effective engagement of all regulatory frameworks with local communities and their knowledge.

Australia's Government-Industry Partnership – a cornerstone of the biosecurity system

Greg Fraser, *Plant Health Australia*

The ability of governments and industries to work together and share responsibility for designing and managing the plant health system in Australia has been a crucial development over the last 15 years. It has provided options for achieving improvements in biosecurity and addressing nationally significant challenges that did not exist previously and that have not been possible in other parts of the world.

Plant Health Australia (PHA), as the independent national coordinating body for plant biosecurity in Australia, has played a crucial role in building and facilitating agreement to the frameworks and systems that have managed post-border pest and disease threats, which have supported the nation's plant health status, and which have maintained and grown market access for Australia's plant products.

PHA, as well as being custodian of the Emergency Plant Pest Response Deed, also facilitates and coordinates action on a range of strategic policy issues and programs of national significance. Increasingly, Members are seeking to extend PHA's role into areas where PHA's technical expertise, impartiality and track record make it ideally positioned to coordinate partnership approaches and provide a national perspective on plant biosecurity and the future of Australia's plant health system. One example of this is PHA's facilitation of Australia's National Plant Health Strategy and a range of underpinning strategies for surveillance, diagnostics, training and communication.

There is much goodwill and commitment across the biosecurity sector, but clearly some challenges exist. One of these is how the government/industry partnership can be used to achieve better outcomes in difficult climatic, economic and trading circumstances.

PHA is committed to providing national coordination services to strengthen key parts of the plant health system. As Australian agricultural biosecurity is reshaped following the Beale Review, PHA's role as an impartial broker in biosecurity issues will remain critical.

Biography: Greg Fraser is an Executive Director and the Chief Executive Officer of PHA. Greg has held a number of business and industry positions, including inaugural Chairman, Agrifood Awareness Australia, Chairman of a number if agribusiness focused committees, and President, Weed Society of Queensland. More recently he has been Chairman of the Australian Agriculture and Natural Resources Online (AANRO) Management Committee, a member of the Industry Advisory Committee of the EH Graham Centre for Agricultural Innovation, the national committee on elevated CO2 research, and the Signposts and Climate Change Research Strategy for Primary Industries reference groups.

The role of animal health laboratories in managing the risks from infectious diseases

Martin H. Jeggo, *CSIRO Livestock Industries Australian Animal Health Laboratory*

The animal health laboratory has a critical role to play both in assisting surveillance activities aimed at detecting the presence of an infectious disease that poses a risk to livestock, or those that affect animals and man, as well as to confirming and responding to an outbreak. Recent technology advances in terms of diagnostic systems, data management and communication provide a real opportunity to considerably enhance and broaden this role, both in the laboratory but also in the field using "point of care" tests. This paper further describes the role of the laboratory and explores these technology opportunities to further strengthen this role.

Biography: Dr Martyn Jeggo is the Director of CSIRO's Australian Animal Health Laboratory (AAHL) and has headed AAHL since September 2002.Dr Jeggo brings a wealth of experience in controlling and detecting exotic and emerging animal disease to his role of Director. In his time at the facility, some A$55 million has been brought in to improve and upgrade the facility. Prior to joining AAHL from 1996-2002, Dr Jeggo was the Head of the Animal Production and Health Science Section of the Joint Food and Agricultural Organisation/ International Atomic Energy Agency (FAO/IAEA) Division of Agriculture, in Vienna, Austria.

Biosecurity and developing world needs

Perdeep Kumar, *Field Epideimiology & Laboratory Training Program*

Background of Study

Biosecurity address the new complex kind of threats those are aroused by new mutant artificial dangerous kind of biological agents or toxin. As with advances of biotechnology for improving the public health, also increases the risk for misuse of it. These growing threats to international peace, security and stability must be checked .One of the major challenges in biosecurity is the increasing availability and accessibility of potential harmful technology. Biomedical advances improve the public health but it also increasing the risk of making biological weapons. The risk of making biological weapons are more in developing world as compared to developed world. The issue of biosecurity at present are stealing of dangerous pathogens, emerging and reemerging of disease and proliferation of high level biosafety laboratories.

Methodology

Focus group discussion methods was used among the health professionals and laboratory staff. Positive and negative remark of the participant recorded on list of issues of biosecurity.

Results

Stealing of dangerous pathogens from high level biosecurity laboratories had 4 positive, proliferation of laboratories without written code of biosecurity had 3 positive and emerging and reemerging issues of

diseases had 2 positive, availability of technology for biological weapon making 2 Positive, easy access to potential dangerous biological agents and toxin one positive.

Conclusion

Biosecurity is a strategic and integraded approach to make the effect on public health as a whole through the various steps involving agriculture health, animal health and environment around the globe. It is necessary to identify the critical need of capacity building in the field of biosecurity for developing world. It focus the trained professionals in the field of biosecurity ,policy for biosecurity code for high level biosafety laboritories, implementation issues biosafety code especially in the developing world and financial issues of biosecurity.

Key World , Biosecurity, Developing world

Biography: Dr Perdeep Kumar did his MBBS from Allama Iqbal Medical College Lahore Pakistan in 1989. After completing his house jobs in Medicine and Surgery in Services Hospital Lahore he joined Punjab Health Depatment as a Medical Officer. In 2006 he did specialization in Public Health and got Master of Public Health (MPH) degree from Health Services Academy Islamabad Pakistan. In 2007 he was enrolled as fellow in the Field Epidemiology and Laboratories Training Program Pakistan (FELTP) Islamabad. This training program is conducted by Centre for disease control and prevention (CDC) Atlanta,USA with National Institute of Health Islamabad Pakistan.

The economics of biosecurity: import risk, border quarantine, local surveillance and eradication measures

Tom Kompas, *Australian National University* and Tuong Nhu Che, *Australian Bureau of Agricultural and Resource Economics*

Import risk analysis, border quarantine, local surveillance and eradication measures provide an essential protection against the entry and spread of exotic invasive species, protecting both agricultural production and the environment against harmful and potentially devastating pests and diseases. However, these measures also impose costs such as trade restrictions and the expenditures associated with each measure, from border control to containment and eradication campaigns. This paper summarizes economic model-specific approaches to import risk, border control and local surveillance measures, using stochastic bioeconomic models to determine optimal levels of expenditure against conceivable threats, and risk-adjusted techniques for the cost-benefit analysis of eradication measures. Case study examples for Pierce's disease as an import risk, Ovine Johne Disease in Western Australia, Papaya Fruit Fly in Queensland and Red Imported Fire Ant in Brisbane are provided.

Biography: Tom Kompas is Professor of Economics and Deputy Director in the Crawford School of Economics and Government, Australian National University (ANU). He is the Foundation Director of the Australian Centre for Biosecurity and Environmental Economics (AC BEE), Editor of the ***Australian Journal of Agricultural and Resource Economics*** and in 2009 was a recipient of the ANU's highest award for teaching, the 'Vice Chancellor's Award for Excellence in Teaching'. His bioeconomic modelling and biosecurity research has been published in the world's leading international journals (including ***Science***) and his current work focuses on the major biosecurity issues in both Australia and internationally.

Principles of phytosanitary biosecurity surveillance

Brendan Murphy, Paul De Barro and Darren Kriticos, *CSIRO Entomology and Cooperative Research Centre for National Plant Biosecurity*

Biosecurity surveillance to detect invasive phytophagous pests associated with trade and tourism is a relatively new discipline, and accordingly, established principles and strategies are lacking. We have identified four major themes which we consider important in surveillance: pathway focus, scalability, quality measurement and the dual-arms strategy. Surveillance needs to be targeted at trade and tourism pathways to ensure limited surveillance resources are applied where the probabilities of pest entry and establishment, and hence their detection, are greatest. If we accept that 'baseline' surveillance covers extensive areas (e.g. national scale) at very low intensity, and 'response'

programmes use highly intense surveillance effort at a localised scale, it becomes clear that surveillance must be scalable to allow use of the same programme for different biosecurity roles/intensities. Because surveillance programmes may run for long periods without detections (particularly if the target pest is absent), and because detections do not necessarily infer good surveillance, it is important to incorporate quality measurement indicators that describe how programme quality changes over time in a manner that is independent of detections. Despite the inherent uncertainty in biosecurity and almost complete inability to predict the next pest to establish, surveillance practitioners often speculate limited surveillance resources on a few 'winners'; these may never arrive and at most a handful of species could ever be detected. The solution is a dual-arms approach using broad-spectrum surveillance covering an extensive range of plant species to detect the widest range of pests, with this tactic augmented by pest-specific surveillance where gaps are identified or better tools (e.g. pheromones) available. These principles and how they are operationally applied are examined across two contrasting surveillance approaches in forest biosecurity surveillance in New Zealand, the broad-spectrum High Risk Site Surveillance (HRSS) and pest-specific gypsy moth (*Lymantria dispar* L.) surveillance.

Biography: Brendan's research background is in forest health including a PhD on biocontrol of chrysomelid pests of *Eucalyptus* and *Acacia* in New Zealand. He subsequently spent three years with the New Zealand Ministry of Agriculture and Forestry developing the national forest biosecurity surveillance strategy, included designing and managing the High Risk Site Surveillance (HRSS) and gypsy moth surveillance programmes. Following contracts as a Forest Field Officer and Forest Project Coordinator with a state owned enterprise, Brendan accepted a post-doctoral position with CSIRO Entomology in Australia in 2008 where he currently works in phytosanitary risk analysis.

Are we on the right track to manage invasion pathways?

Philip Eric Hulme, *Bio-Protection Research Centre*

Humans have traded and transported alien species for millennia with two notable step-changes: the end of the Middle Ages and beginning of the Industrial Revolution. However, in recent decades the world has entered a new phase in the magnitude and diversity of biological invasions: the Era of Globalization. Increasing transport networks and demand for commodities have led to pathway risk assessments becoming the frontline in the prevention of biological invasions. Pathways describe the processes that result in the introduction of alien species from one location to another. A framework is presented for the comparative analysis of invasion pathways by a wide range of taxa in terrestrial and aquatic ecosystems. Alien species may arrive and enter a new region through three broad mechanisms: importation of a commodity, arrival of a transport vector, and/or natural spread from a neighbouring region where the species is itself alien. These three mechanisms result in six principal pathways: release, escape, contaminant, stowaway, corridor and unaided. The diverse routes of introduction are complex. Nevertheless, common features enable comparable approaches to risk assessment. Comparisons with a range of data help identify existing gaps in current knowledge of pathways and highlight the limitations of existing legislation to manage introductions of alien species. Intentional releases and escapes should be straightforward to monitor and regulate but, in practice, developing legislation has proved difficult. New introductions continue to occur through contaminant, stowaway, corridor and unaided pathways. These pathways represent special challenges for management and legislation.

Biography: Philip Hulme is Professor of Plant Biosecurity at the Bio-Protection Centre, Lincoln University. His primary research interests relate to understanding the ecology of invasions by introduced plant species, assessing the subsequent consequences for natural and managed ecosystems and developing tools to help prevention or management. Current research addresses our ability to predict which plant species may become invasive and examines the roles of habitat characteristics, plant species traits and human behaviour in the risk of plant invasions.

The consequences of fire blight in Australian pome fruit industries

David C. Cook, *CSIRO Entomology*, *Cooperative Research Centre for National Plant Biosecurity andf The Australian National University, Fenner School for Environment and Society,* Shuang Liu, *CSIRO Entomology and Cooperative Research Centre for National Plant Biosecurity*, Abu-Baker M Siddique,

Art Diggle, *Department of Agriculture and Food - Western Australia and Cooperative Research Centre for National Plant Biosecurity,* Michael Hurley and Kim E Lowell, *Department of Primary Industries Victoria and Cooperative Research Centre for National Plant*

Fireblight is a bacterial disease of apples and pears first discovered in the United States in the late-eighteenth century now found in many fruit producing regions of the world, including New Zealand. It remains absent from Australia, a fact that has seen imports of susceptible commodities banned. This has been a source of on-going tension between Australia and New Zealand for more than twenty years in regards to a ban on apple imports. In this paper, we explore the reasoning behind Australia's precautionary measures using a bioeconomic impact simulation model. We use the model to examine several different fire blight outbreak scenarios and response strategies from industry and government, and demonstrate the effects of a variable rate of spread, time until detection and control effectiveness. We show that despite the relatively high profile of fire blight, there remains a great deal of scientific and economic uncertainty about its affect on Australia if introduced.

Biography: David hails from the Great Southern region of Western Australia. He completed a Bachelor of Economics degree at Murdoch University in 1995, and from 1996-2004 worked as a Regional Economist with the Western Australian Department of Agriculture investigating invasive species issues. During this period David completed a PhD with The University of Western Australia's School of Agricultural and Resource Economics (1999-2001), and worked as a postdoctoral research assistant at Imperial College London (2003-2004). In 2005 he took up a Research Economist position with CSIRO Entomology in Canberra, and an adjunct appointment with the Australian National University's Fenner School of Environment and Society

A modelling framework for understanding the impacts of climate change on biosecurity incursions of cropping systems

Hazel Parry, Darren J. Kriticos, Paul De Barro, *CSIRO Entomology and Cooperative Research Centre for National Plant Biosecurity,* Jean-Philippe Aurambout, *Future Farming Systems Research, Department of Primary Industries and Cooperative Research Centre for National Plant Biosecurity*, Wendy Griffiths, *Department of Primary Industries and Cooperative Research Centre for National Plant Biosecurity*, Kyla Finlay and Jo Luck, *Biosciences Research Division, Department of Primary Industries*

Relationships between a crop, pathogenic disease and a pest that vectors the pathogen can be complex. A key driver of change in these relationships is weather. Projected climatic changes are likely to alter the dynamics of such crop-vector-disease system, presenting us with new biosecurity challenges from existing pests. Barley Yellow Dwarf Virus is a widespread pest of wheat crops that is vectored by an aphid, *Rhopalosiphum padi*. We are developing a spatially-explicit process-based model using DYMEX to simulate the population dynamics of the aphid in several agricultural landscapes of Australia. This model will be sensitive to the influence of the environment, including weather, on: (1) the habitat of the species (incorporating a wheat growth model); (2) the species' population dynamics and phenology and (3) the dispersal of the aphid with subsequent disease spread (barley yellow dwarf virus). This tri-trophic model will enable us to project the outcomes of various future climate scenarios for the wheat-aphid-disease system in these regions. The heuristic understanding gained from this modelling will inform adaptation options aimed at making robust future-oriented biosecurity decisions. We present the model development to date, highlighting the sensitivity of the aphid population dynamics and phenology to projected climate changes, including the influence of the wheat host sub-model.

Biography: Dr Parry recently joined CSIRO Entomology, Canberra, as a Postdoctoral Research Fellow, following seven years experience of developing ecological models in the UK. Dr Parry has a range of experience in the development of individual-based models and the use of Geographical Information Systems. Dr Parry's research interests include: computer simulation of crop pest population dynamics and dispersal, understanding the implications of landscape and environmental change for crop-pest-pathogen dynamics, environmentally sensitive farming, and the advancement of high performance computing solutions for modelling, such as grid computing.

An integrative approach to understanding the pest and disease threats to agricultural biosecurity under future climates

Jo Luck, K.J. Finlay, *Biosciences Research Division, Department of Primary Industries and Cooperative Research Centre for National Plant Biosecurity*, J-P Aurambout, *Cooperative Research Centre for National Plant Biosecurity and Future Farming Systems Research, Department of Primary Industries*, W. Griffiths, *Cooperative Research Centre for National Plant Biosecurity and Department of Primary Industries*, G. O'Leary, A. Freeman, G. Holloway, P. Trebicki, *Department of Primary Industries*, K. Powell, *Cooperative Research Centre for National Plant Biosecurity and Biosciences Research Division, Department of Primary Industries*, R. Norton, *The University of Melbourne* , Darren Kriticos, *CSIRO Entomology and Cooperative Research Centre for National Plant Biosecurity*, Fiona Constable, *Biosciences Research Division, Department of Primary Industries* and S. Chakraborty, *CSIRO Plant Industries and Cooperative Research Centre for National Plant Biosecurity*

Despite increasing knowledge of the predicted impacts of climate change, the potential threats to agricultural biosecurity remain uncertain. In this study, models have been developed to better predict the responses of pest and disease threats to our changing climate. By coupling host-plant physiology, virus and vector population growth and climatic data with projected climate change conditions, we are able to predict individual species responses and shifts to historic geographic ranges. Strengthened by empirical data, these models are intended to be incorporated into plant biosecurity management and contingency planning, forming the basis of integrated scenario-based decision support systems for emergency pest and pathogen management. Current work focuses on developing an innovative spatial modelling environment using the bird cherry-oat aphid (*Rhopalosiphum padi*) which vectors *Barley yellow dwarf virus* (*BYDV).* The effect of climate change on aphid feeding behaviour, flight time and synchrony with the crop, virus acquisition and transmission rates and wheat phenology changes and physiological responses are being incorporated. Experiments in the Australian Grains Free Air Carbon Dioxide Enrichment (Ag FACE) research facility have enabled field based investigations of the effects of elevated (e) CO_2 on wheat pathosystems. Wheat stripe rust (*Puccinia stiiformis*) and crown rot (*Fusarium pseudograminearum*) severity, latent period, fecundity and host resistance was assessed under ambient and 550ppm CO_2. While no effects of the treatment were observed with *P.striiformis* over two seasons, an increase in *F.pseudograminearum* biomass under eCO_2 has been observed in 2008. Our integrated modeling and field based approach to resolving the likely effects of climate change to plant biosecurity will be presented.

Biography: Dr Jo Luck is Principal Research Scientist, Plant Microbiology for DPI Victoria. In collaboration with CSIRO, Jo and her team are investigating the responses of pests and diseases of wheat to climate change using an integrative modelling and field based approach.

Effects of expansion in human activity and climate change on plant virus introductions and emergence

Roger A. C. Jones, *Agricultural Research Western Australia and School of Plant Biology, Faculty of Natural and Agricultural Sciences, University of Western Australia*

This talk will discuss how rapid expansion in human activity and climate change are impacting on plants, vectors and viruses worldwide, and how this process poses a global threat not only to food and fibre production but also to plant biodiversity and the environment. It will start by considering introductions through long distance movement of damaging viruses and their vectors away from centres of plant domestication in different parts of the world to other continents. It will then describe how rapidly expanding human activities increasingly facilitate damaging new encounters between plants, vectors and viruses globally. The major driving factors involved in virus and vector introductions and virus emergence, and the likely effects of climate change in influencing this process in the future will be emphasised. Finally, the kinds of challenges posed by rapidly changing world conditions to achieving effective control of virus and vector introductions and damaging epidemics of emerging plant viruses, and the approaches needed to address them will be described.

Biography: Roger Jones is the Principal Plant Virologist at Agricultural Research Western Australia and Adjunct Professor of Plant Virology at The University of Western Australia and Murdoch University, Perth. He was also the former Chairman of the International Plant Virus Epidemiology Group within the International Society for Plant Pathology.

Impact of climate change on food security and biosecurity in small Pacific nations

Angela Freeman, *Department of Primary Industries- Horsham*, Pita Taufatofua, *International Agricultural Consultant*, Brendan Rodoni and Jo Luck, *Department of Primary Industries and Cooperative Research Centre for National Plant Biosecurity*

The impacts of climate change on food security and biosecurity in four small Pacific nations will be assessed. The aim of the scoping study is to determine common and individual issues for the countries, particularly in relation to productivity and biosecurity of food crops and the implications for food genetic resources and market access of export commodities.

Climate change will increase threats to food security in the Pacific region through direct impacts on food production and the ability of countries to import food supplies. Climate-related disasters are predicted to increase and will place increased pressure on Pacific countries to maintain adequate agricultural systems for food production. These climatic events combined with possible changes in the movement of food products within the region will expose Pacific countries to new biosecurity threats.

The focus of this project will be to train scientists at the ground level to identify the impact of climate change on local agriculture. A survey and questionnaire of participating countries will be conducted to identify the impacts of climate change on each of the agricultural systems and a workshop will be held to collate the data, identify key issues and generate a number of recommendations for further consideration. The recommendations will be used to develop research projects and identify education scholarships and training placements for regional scientists. The outcomes of this project will enable Pacific agricultural scientists to better prepare and adapt to climate change through better understanding of the key vulnerabilities in their crop production systems and improved collaboration, networking and training.

Biography: Dr Pita Taufatofua has over 40 years experience in agricultural training, research and extension services in the Pacific region. Pita completed his agronomy PhD from the University of Queensland in 1993 and has worked as the Head of Research-Extension Division, Ministry of Agriculture and Forestry (MAF) in Tonga from 1996 to 2006. Currently Pita is working as a Free Lance Consultant throughout the South Pacific region and has strong links with the FAO and the Secretariat of the Pacific Community.

Assessing the risk of plant pathogens in the irrigation channels of the Ord River Irrigation Area

Rebecca E. Zappia, *Cooperative Research Centre for National Plant Biosecurity and Centre for Phytophthora Science and Management, School of Biological Science and Biotechnology, Murdoch University*, Daniel Huberli, *Centre for Phytophthora Science and Management, School of Biological Science and Biotechnology, Murdoch University and Department of Agriculture and Food Western Australia*, Giles E. St J. Hardy, *Centre for Phytophthora Science and Management, School of Biological Science and Biotechnology, Murdoch University* and Kirsty L. Bayliss, *Cooperative Research Centre for National Plant Biosecurity and Centre for Phytophthora Science and Management, School of Biological Science and Biotechnology, Murdoch University*

The Ord River Irrigation Area (ORIA), located in the Kimberley region of northern Western Australia, is one of the single largest irrigated food production areas of the State, with approximately 14,000 hectares of land currently in use for intensive irrigated agriculture. In 2007/08, the value of irrigated farm activity, specifically crops and forestry, in the ORIA was estimated at nearly $96 million. This value is only expected to increase, with expansion of the ORIA currently underway, and a further 14,000 hectares of land for intensive irrigated agriculture expected to be released.

In 2006, the OrdGuard Regional Biosecurity Plan was initiated for the ORIA to minimise the threat of pests and diseases in the region. At present, no plant pathogens are known to exist in the irrigation channels, but to protect the ORIA from future incursions, a knowledge of the pathogen population of the channels is required.

Research is currently underway to detect any plant pathogens present in the irrigation channels of the ORIA, and their likely impact on plant biosecurity for the region. From this research two key objectives will be met. Firstly the best methods for detecting and monitoring plant pathogens in the irrigation channels of the ORIA; and secondly, the ability of these plant pathogens to survive long term in the channel system and their capacity to spread. This research will assist to refine the OrdGuard Biosecurity Plan to enhance biosecurity in the region. Preliminary research results and their implications for other irrigated horticultural and agricultural regions will be discussed.

Biography: In 2008, Rebecca completed a BSc (Hons) in Molecular Biology from the Centre for *Rhizobium* Studies at Murdoch University. His research focused on Plant Growth Promoting Rhizobacteria, and mechanisms they employ to enhance host plant root development. Currently, he is enrolled as a PhD student with the Cooperative Research Centre for National Plant Biosecurity, due for completion in 2012.

Monitoring market infection status

John Weaver, Leo Loth and Ken Inui, *FAO*

Livestock markets are an aggregation point where animals are brought in from multiple sources; animals are often poorly segregated in the market and may be mixed in the market or during delivery from the market. As such markets present a high risk for the transmission of infection and monitoring and control of this risk is necessary. Further markets provide a convenient single site, opportunity to monitor the health of the supplying livestock populations.

Environmental sampling for bacterial loads is well documented and widely used, however the use of aggregation point sampling for viruses is not so well documented.

In SE Asia the numerous live bird markets and the epidemic of Highly Pathogenic Avian Influenza provides an opportunity to both monitor the infection status of the market and of the health of incoming birds.

This paper will present findings from work in Indonesia and Viet Nam that has looked at non-bird handling environmental sampling to estimate the market infection status. Further it will discuss a recent study on the use of air sampling - a technique which has shown great potential.

Biography: John Weaver is a veterinary epidemiologist working as a Chief Technical Adviser for FAO on HPA control programmes in South East Asia for 5 years. His particular interest is surveillance systems and risk reduction through the production/marketing chain.

Preventing and managing incursions of class 1 weeds in Queensland

Michael D. Day and F. D. Panetta, *Department of Employment, Economic Development and Innovation*

With an increase in the number of potential weeds entering Australia, there is a growing need to prevent and/or manage incursions more efficiently. At the federal level, Australia, through the Northern Australian Quarantine Service (NAQS), has three systems (pre-border, border and post border) in place to reduce the chance of invasive organisms becoming established. At the state level, staff in Biosecurity Queensland, a section of the Queensland Department of Employment, Economic Development and Innovation, are also working to minimise incursions and to eradicate where possible, weeds that do establish in Queensland. These efforts involve extensive education and awareness, and surveillance and monitoring of high risk areas and sites of incursions. Such efforts can be highly cost-effective, especially if eradication succeeds. However, they can also be very expensive. More recently, staff in Biosecurity Queensland have been involved in targeting known pathways of entrance by weeds. If populations of a known weed can be reduced in a neighbouring country then the chance of it being introduced into Queensland is also reduced. For some weeds, these pathways are well known.

Biosecurity Queensland has been involved in several projects targeting important weeds such *Chromolaena odorata* and *Mikania micrantha* in East Timor, PNG and Fiji. The combined efforts of NAQS and Biosecurity Queensland should reduce the number of incursions into Queensland and allow more resources to be allocated to eradication efforts against any weeds that do establish.

Biography: Michael Day is a Senior Entomologist at the Alan Fletcher Research Station working on the biocontrol of tropical weeds.

Pig producers' perceptions of the human swine influenza A (H1N1) outbreak and its effect on their biosecurity practices

Navneet Dhand, Marta Hernandez-Jover, Trish Holyoake, *University of Sydney* and Mel Taylor, *University of Western Sydney*

The human swine influenza A (H1N1) was first reported in Mexico and the USA in April 2009, and within two months, the WHO declared a pandemic situation. By January 2010, 208 countries worldwide have reported H1N1 cases, including 13,500 deaths. In Australia, 37,500 confirmed cases and 191 deaths have been reported. Due to naming of the disease as 'swine flu' originally, there appeared to be a general misunderstanding in the public about transmission of disease. In Australia, some retailers reported a significant decline in pork sales due to the outbreak. This study aimed to evaluate pig producers' perceptions about the cause, origin and transmission of the virus; the financial impact of the outbreak on producers; and, the influence of the outbreak on their on-farm biosecurity practices.
A questionnaire, containing 19 closed, semi-closed and open questions, was designed and distributed to members of Australian Pork Limited (APL; n = 460). Response was obtained from 182 producers (39.6%). Of these, only 3% stated a decrease on pigs sold due to the outbreak. Producers considered public transport, community gathering and shaking hands as the most likely sources of H1N1 infection in humans, while eating cooked or uncooked pork, drinking tap water and working in a pig farm, extremely unlikely sources. Some producers modified biosecurity practices after the human H1N1 outbreak, including asking employees to notify flu-like symptoms (44%), asking visitors about overseas travel (26.5%), and not allowing visitors on the farm (18%). Producers relied on APL, veterinarians and government as sources of information. Results indicate producers were well informed about the potential H1N1 virus transmission.

Biography: After finishing the Veterinary Degree, Marta conducted a PhD on swine traceability at the University Autònoma of Barcelona (Spain). Marta moved to Australia as the research responsible of a company specialised on livestock electronic identification. In September 2006, Marta joined the Farm Animal and Veterinary Public Health group at The University of Sydney as a postdoctoral researcher, working on an ABCRC project on biosecurity among small-holding pig producers. In October 2007, Marta was appointed as the ABCRC Epidemiology Research Fellow. Since then, she has been working on public health, epidemiology and risk analysis.

Biosecurity practices of Australian horse owners one year after the 2007 outbreak of equine influenza

Kathrin Schemann, Simon Firestone, Navneet Dhand, *University of Sydney*, Melanie Taylor, Jenny-Ann Toribio, *University of Western Sydney,* Kingsley Agho and Michael Ward

The 2007 outbreak of equine influenza in Australia caused substantial emotional and financial hardship. We conducted a cross-sectional study of 1283 Australian horse owners to determine biosecurity practices and perceptions one year after the 2007 equine influenza outbreak.

We used an online survey, with a link directed to the affected population via a number of industry groups. Biosecurity compliance (low, medium, high), as determined by horse owners' responses to a 16 item question on the frequency of various biosecurity measures, was used as the outcome variable. Explanatory variables with univariable likelihood ratio chi-square p-value of <0.25 were tested in multivariable ordinal logistic regression models. Variables with a p-value <0.05 in multivariable models were retained in the final model. Two potential confounders - age and gender of participants- were included in the final model irrespective of their p-values.

In total, 1283 respondents participated in this study but only 1195 observations were used in the final model due to missing values. Horse owners who perceived that it was difficult to maintain biosecurity recommendations had lower biosecurity compliance than those who deemed practices as easy to do. Those who feared a future outbreak of equine influenza a little had lower compliance than those who were very fearful. Young horse owners achieved a lower biosecurity index than their older counterparts. Horse owners who did not experience long-term business impacts had lower biosecurity compliance than those who did.

We characterized a group of horse owners with low levels of biosecurity compliance. This group poses a higher risk for the spread of equine diseases and should be targeted for extension activities to change their biosecurity perceptions and increase biosecurity compliance in the Australian horse industry.

Biography: Kathrin is an animal scientist and currently a PhD candidate at the University of Sydney in Veterinary Epidemiology. She undertook an honours research year for her Animal and Veterinary Bio Science degree in 2008. Her honours work was supported by the ABCRC and comprised an assessment of the disease surveillance activities for pigs at abattoirs and saleyards in New South Wales. Currently, Kathrin is investigating biosecurity perception and practices of horse owners and horse industry participants and the policy implementation process during the 2007 outbreak of equine influenza in Australia.

Public perceptions and conceptions of the human swine influenza A (H1N1) outbreak

Navneet Dhand, Marta Hernandez-Jover, Trish Holyoake, *University of Sydney* and Mel Taylor, *University of Western Sydney*

2009 was the year of pandemic influenza when a new strain of the influenza virus, A/H1N1, spread from Mexico to more than 200 countries by the end of the year causing more than 12,000 deaths worldwide. We conducted this study in the Greater Sydney region in Australia, during winter 2009 to investigate peoples' perceptions on the cause and transmission of the virus; the sources of information influencing their perceptions; and the effect of peoples' perceptions on pork consumption. A questionnaire was administered to people visiting butcher shops selected through a pork supplier. The questionnaire, approved by a Human Ethics committee, had 13 closed, semi-closed and open questions and was and trialed on four persons prior to implementation.

More than two-thirds of the participants considered the federal health department (72.8%), the state health department (70.2%), and their general practitioners (GPs) (69.8%) to be extremely or very-important sources of information regarding human swine flu. From amongst the media sources, people considered television, newspaper and radio to be important sources of information on human swine influenza (in that order). Interestingly, about half of the respondents did not consider internet to be of any importance for this purpose. About 22% of the respondents had a misconception that avoiding eating pork would protect them from contracting human swine influenza and about 16% believed that they could contract the disease by eating cooked pork. However, about 89% of people did not make any changes to their pork eating habits.

More than three fourth of the respondents were broadly concerned that they would catch human swine flu if the disease were to become widespread in their area but even a greater proportion were concerned that their family or loved one would catch infection. A majority of the respondents thought that the outbreak was managed well, although many believed that media overreacted to the situation and that the seriousness of the disease was exaggerated. Public perceptions about the importance of biosecurity in preventing infection will be discussed at the conference.

Biography: Originally trained as a veterinary in India, Navneet is currently working as a Lecturer in Veterinary Biostatistics and Epidemiology at The University of Sydney. In 2007, he was awarded the inaugural Chris Baldock Prize for achieving the highest score in the membership examination of the Australian College of Veterinary Scientists (Epidemiology Chapter) and in 2008 he completed his PhD on identification of risk factors for ovine Johne's disease in Australian sheep flocks. Navneet has worked in a range of research areas over the past 10 years and is interested in risk factor investigation, disease surveillance, outbreak investigations and computational statistics.

Village-level biosecurity for large ruminant transboundary disease risk management in northern Laos

Peter Windsor, Luzia Rast, Sonevilay Nampanya, *Faculty of Veterinary Science, University of Sydney* and Syseng Khounsey, *Department of Livestock and Fisheries, Lao PDR*

The ACIAR research project AH2006/159 "Best practice cattle and buffalo health and husbandry, Lao PDR' is a 4 year study that commenced in May 2008, managed by this Faculty in collaboration with the Department of Livestock and Fisheries (DLF) in Luang Prabang, northern Laos. The research supports development projects that are building the capacity of large ruminant industry stakeholders to move smallholder subsistence husbandry towards a more integrated, disease-free production system, thus improving household incomes in one of the regions of southeast Asia. Recent adoption of forage technology by farmers has led to ruminant fattening, with animals exported to Vietnam at premium prices. The increased return from this trade has provoked interest by farmers in animal health and offers an opportunity to address disease control at the villager level. The project involves a 3 year longitudinal survey on morbidity, mortality, production and economics in 6 northern Lao villages, comparing the impacts of a series of interventions in 'high intervention' compared to 'low intervention' villages. With additional support from the Crawford Fund, our project team has been delivering training workshops in a range of disciplines to provincial DLF and others involved in the large ruminant sector. Surveys on farmer attitudes to improving large ruminant production, plus knowledge of biosecurity, risk of transmission of transboundary diseases and large ruminant health and production, have been used to develop a village-level system of biosecurity and disease surveillance that may contribute to national and regional control of transboundary diseases, particularly Foot and Mouth Disease (FMD). In January 2009, an FMD outbreak was reported in Xiengkhuan province involving two ACIAR project villages located in that province where FMD vaccination had occurred in December 2008. Data was collected from these and 2 other villages affected by FMD outbreak. Morbidity and mortality rates were significantly lower in the recently vaccinated villages suggesting that FMD vaccination in face of an outbreak is highly beneficial in reducing morbidity.

Biography: Professor Peter Windsor BVSc(Hons; 1977), PhD (1988), DVSc (2007) is Chair of Livestock Health and Production, Faculty of Veterinary Science, University of Sydney. Peter worked in laboratory and field research roles with NSW DPI and for FAO on FMD eradication in the Philippines. Since 2002 he has taught ruminant health & production and rural public practice to undergraduates and supervises 6 PhD and numerous Honours students. His research is funded through ACIAR and AB-CRC (large ruminant health and husbandry in Asia), ARC-Linkage (analgesia for livestock husbandry), MLA (control of paratuberculosis in sheep, epidemiology of bovine chondrodysplasia), plus Invasive Animals CRC (Neosporosis).

Opportunity lost? Impacts of and responses to biosecurity breaches due to aquatic animal pathogens and their introduced hosts in Australia

Richard Whittington, Joy Becker *Faculty of Veterinary Science, University of Sydney* and Brian Jones, *Department of Fisheries, Western Australian Department of Primary Industries*

The Australian aquaculture and fisheries sector has enjoyed unique competitive advantage due to inherent freedom from infectious diseases which have plagued other countries. Furthermore, our unique endemic aquatic biota, which are of high conservation value, are evolutionarily naive with respect to exposure to many pathogens, so the impacts of disease can be severe. However, evidence is accumulating to show that our geographic isolation is no longer sufficient protection. Anthropogenic factors leading to disease emergence and spread are now so numerous and difficult to regulate due to industrialisation and free trade ambitions that we need to develop new methods to assess, manage and live with new disease incursions. Paradoxically, domestic movements of animals and their pathogens may be as harmful as potential international threats. This paper examines representative contemporary examples of viral, bacterial and protozoal disease incursions in free-living aquatic species, their sources, and their impacts in the natural environment and in the aquaculture and fisheries sector. The management responses that were applied are reviewed. Australia sits as a barrier across two great oceans, the Torres strait zoogeographic boundary in the north and the subantarctic convergence in the south. Animals movements from Cairns to Perth or Darwin, or from Sydney to Perth could be of

greater biosecurity significance than moving animals from Auckland to Sydney (since currents and fauna move east from Sydney to Auckland) or from Java to Broome (as fish swim greater distances), yet Australia concentrates resources into managing international movements. The role of introduced vertebrate and invertebrate carrier (pest) hosts in the maintenance and spread of exotic pathogens will be discussed while a decision tree to enable assessment of the likely impact of an emerging aquatic disease and an optimal management response will be presented. The recommendations have relevance for terrestrial species.

Biography: Professor Richard Whittington is Chair of Farm Animal Health and immediate past Chair of the Veterinary Public Health Management Program in the Faculty of Veterinary Science at the University of Sydney. His research interests include infectious diseases of aquatic animals, terrestrial animals and free living wildlife. He leads research to assess introduced viral diseases in the Murray Darling Basin and to control viral diseases in aquaculture in Australia and Indonesia. He is nominated technical expert on Epizootic haematopoietic necrosis virus of finfish and ranavirus of amphibians for the World Organisation for Animal Health (OIE) and manages the international reference laboratories with CSIRO.

HENDRA VIRUS – disease ecology and emergence

Hume Field, *Biosecurity Queensland, Department of Employment, Economic Development and Innovation, and the Australian Biosecurity Cooperative Research Centre for Emerging Infectious Diseases*

Four of the eleven recognised Hendra virus incidents in horses have involved transmission to humans, most recently in July 2008 when a veterinarian and a veterinary nurse were infected, the former fatally.

Low infectivity but high case fatality rates are features of infection in both horses and humans. Infection appears not to transmit readily from bats to horses, nor from horse to horse, nor from horses to humans; however, once infected, horses have a 75% probability, and humans a 50% probability, of a fatal outcome. Fruit bats are the natural reservoir of the virus. All human cases are attributed to exposure to infected horses; there is no evidence of bat-to-human transmission.

Hendra virus can cause a range of clinical signs in horses, a legacy of its affinity for endothelial cells. The predominant clinical presentation may depend on which organ system sustains the most severe endothelial damage, and be influenced by route of infection and virus strain.

Animal health authorities in Australia foster increased awareness, alertness and preparedness in the horse-owning and veterinary communities, and encourage husbandry practices that minimize risk of exposure. Veterinarians should routinely consider Hendra virus as a differential diagnosis when presented with a febrile horse, should use a risk-based approach to personal protective equipment, and should maintain good infection control practices at all times.

Minimisation of the future occurrence and impact of Hendra virus requires an understanding of the factors that promote spillover from bats, an informed risk-based approach by owners and veterinary practitioners, and early involvement of animal health authorities. Research into effective vaccines and effective human therapeutics continues.

Biography: Dr Field is an internationally recognized authority on emerging infectious diseases associated with bats. He played a key role in the identification of fruit bats as the natural hosts of Hendra virus in Australia and Nipah virus in Malaysia. He participated in two WHO missions investigating the origins of the SARS outbreak in 2003, and was part of the team that identified bats as the reservoir of a cluster of SARS-like coronaviruses. His current research focus includes risk factors for henipavirus spillover, and investigations of SARS-like coronaviruses in bats. He is a principal veterinary epidemiologist with Biosecurity Queensland in Brisbane, Australia, and is also a Visiting Professor of Zoonoses at The University of Malaysia, Sarawak.

Grains post entry quarantine – threats, pathways and prevention

Brendan Rodoni, Linda Zheng, *Cooperative Research Centre for National Plant Biosecurity and Department of Primary Industries- Knoxfield*, Angela Freeman, *Cooperative Research Centre for National Plant Biosecurity and Department of Primary Industries- Horsham*, Gerard Clover,

Cooperative Research Centre for National Plant Biosecurity and Plant Health and Environment Laboratory, MAF, Biosecurity New Zealand, John Thomas, *Cooperative Research Centre for National Plant Biosecurity and Queensland Department of Primary Industries*, Kevin Davis, *Cooperative Research Centre for National Plant Biosecurity and Biosecurity Australia* and Mark Whattam, *Cooperative Research Centre for National Plant Biosecurity and AQIS*

The Australian Quarantine and Inspection Service (AQIS) facilitates the importation of over 2000 seed lines as well as 500 horticultural cultivars, 500 high risk and 70,000 medium risk ornamental plant lines/cultivars each year. Plant material imported for propagation is visually inspected and typically fumigated to eliminate insect pests. Disease risks associated with grain imports are managed through overseas certification stating freedom from regulated pathogens, appropriate treatments including hot water and fungicide treatments and visual screening of many of the obligate pathogens including viruses.

There is an urgent need for additional phytosanitary procedures as the current reliance on visual inspections for disease screening of cereal seedlings in PEQ approved and open quarantine premises has inherently greater risks for incursion of exotic seed-borne pests (Radcliffe *et al.*, 2003). For example, the Australian wheat industry is valued at over $5 billion annually and is free of many of the major pests and diseases that affect the industry overseas. However the threat of introducing an exotic disease is significant as the movement of international germplasm, currently estimated at 23 tons of wheat germplasm shipped globally, is increasing. There are several pathways for the introduction of winter cereals into Australia and include importation of seed or clonal grasses through an AQIS Post Entry Quarantine station or a quarantine approved premise including open quarantine facilities (seed only).

Access to reliable diagnostic tools to assist Quarantine Pathologists in laboratory and field screening is urgently required. Recent research (CRCNPB 40050) has designed a diagnostic test that can reliably detect a group of viruses (the potyvirus genus). Additional tests have been designed for four virus genera that are important for the grains industry; *Furoviruses*, *Hordeiviruses*, *Tritimoviruses* and *Rymoviruses.* At the completion of this project we will be able to detect one third of all known plant viruses, including 14 of the 22 viruses listed under the Australian Emergency Plant Pest Response Deed (EPPRD). Ultimately the goal of this research program is to develop a new diagnostics platform for Post Entry Plant Quarantine to support the detection of Emergency Plant Pests in the Australian Grains and Nursery industries.

Biography: Brendan Rodoni has 25 years experience as a plant virologist with a focus on the detection and epidemiology of plant viruses of temperate and tropical crops. He completed his PhD on molecular plant virology at the Queensland University of Technology in 1997. He currently has a joint appointment as a senior research scientist with the Victorian Department of Primary Industries and as a senior research fellow with Latrobe University and leads a research and development program within the Plant Microbiology platform.

Developing an ecological basis for managing the threat posed by phosphine resistant stored grain beetles in Australia

Andrew Ridley, Greg Daglish, *Queensland Primary Industries and Fisheries; Department of Employment, Economic Development and Innovation and Cooperative Research Centre for National Plant Biosecurity,* Mark M. Stevens, *Cooperative Research Centre for National Plant Biosecurity, EH Graham Centre for Agricultural Innovation and Yanco Agricultural Institute* and G.H. Walter, *University of Queensland, School of Biology*

Phosphine resistant forms of stored grain beetles are a critical biosecurity issue for Australia, and elsewhere.

Knowledge of the ecological processes contributing to the development and spread of resistance is fundamental to managing this problem. Understanding has, however, derived largely from laboratory population studies with relatively little information from the field.

This paper describes the key results obtained from the initial phase of research on the ecology of two major pests, the lesser grain borer (*Rhyzopertha dominica*) and the rust-red flour beetle (*Tribolium castaneum*).

A priority is to quantify the dynamic pattern of distribution and abundance of each beetle species across the rural landscape. A long-term trapping program is under way in two grain growing districts, in Queensland and New South Wales. The traps are baited with species-specific pheromones and located near silos, in paddocks and in native vegetation.

The lesser grain borer adults are widely distributed away from grain storages in the two study areas, and are more abundant there than expected from North American results. The rust-red flour beetle is aggregated around grain storage, which is consistent with results from the USA.

Other research is in progress to test if individual beetles interact with key aspects of their environment in a species-specific way. For example, attempts are being made to characterise beetles emigrating from infested silos by intercepting individual adults as they leave the storage and evaluating them in the laboratory. Results to date show that *R. dominica* females have mated before emigrating, that both sexes typically live for 3 months at 25°C, and that females captured in this way are capable of producing several hundred adult progeny during this time without further mating.

Results such as those described in this paper will provide ecological insights into the evolution and spread of phosphine resistance and therefore contribute to the development of effective resistance management

Biography: Dr Ridley is a Research Scientist with the Queensland Primary Industries and Fisheries. He has research experience in insect vectors of plant viruses and ecology of stored product pests. Dr Ridley is part of a collaborative project in the Cooperative Research Centre for National Plant Biosecurity of grain insect ecology.

Gaps in vertebrate pest biosecurity that need plugging

Anthony Peacock, *Invasive Animals Cooperative Research Centre*

Incursions of vertebrate pests are rare events. Historically, incursions occurred through introduction by humans for livestock or aquaculture, for acclimatization purposes or inadvertently through shipping. The risk of further incursions is often thought to be minimal. However, pathways for incursion of vertebrate pests do exist and warrant examination and action to minimise risk of the establishment of new pest populations.

New pathways for vertebrate incursion have come about through changes in the nature of the animals involved. For example, hybrid dogs and cats (crosses of wild and domestic animals) may have pest characteristics of wild animals but enjoy legal access to a jurisdiction because they may be classified as a domestic animal. In 2008 Australia banned importation of the Savannah cat (a “breed” derived from the serval, *Leptailurus serval*, and domestic cat) but only by cumbersome use of the *Environment Protection and Biodiversity Conservation Act (1999)*. The way remains open to other hybrid dog and cat “breeds”.

In effect, community desire for exotic pets is driving a pathway of invasive animal incursion. In the United States, the Pet Industry Joint Advisory Council is fiercely opposing a proposed importation ban on nine species of python, despite clear evidence of significant environmental problems. Almost all invasive fish incursions in Australia in the past half century have come from aquaria and a process is in place to determine whether fish on a long “grey list” pose acceptable risks.

A further source of potential problems are “game” animals that enjoy legislative protection in certain jurisdictions. In Australia, this situation is exemplified by deer, which are considered pests in four jurisdictions and game in three. In some jurisdictions it is legal (or at least not illegal) to keep species such as pheasants or Indian blackbuck for game hunting, posing a future biosecurity risk.

Biography: Tony Peacock is the Chief Executive of the Invasive Animals Cooperative Research Centre at the University of Canberra in the Australian Capital Territory. The CRC is the largest research effort on invasive vertebrates in the world, with 34 Australian organisations and seven international organisations participating. Tony has a BScAgr (Hons) and PhD from the University of Sydney. He was previously the Managing Director of the Pig R&D Corporation and a researcher at the Universities of

Saskatchewan and Melbourne. He chaired the Australian Biosecurity Group which produced the *Invasive Weeds, Pests and Diseases: Solutions to Secure Australia* policy proposal in 2005.

Pathogens in vertebrate pests in Australia

Wendy Henderson, *Invasive Animals Cooperative Research Centre* and Elaine Murphy, *Invasive Animals Cooperative Research Centre and Department of Conservation*

Vertebrate pests represent a potential biosecurity threat to Australian livestock, native fauna and people. Research identifying pathogens in vertebrate pests in Australia (feral pigs, foxes, wild dogs, feral cats, feral goats, rabbits, cane toads, house mice, ship rats and carp) was reviewed. A range of bacterial, viral, fungal, helminth and protozoan pathogens have been identified, many of which have broad host specificity, potentially affecting a wide range of species.

Pathogens that could significantly impact on native species include *Toxoplasma gondii* (causing toxoplasmosis), *Echinococcus granulosis* (causing cystic hydatidosis) and Asian fish tapeworm *Bothriocephalus acheilognathi*. Pathogens with serious zoonotic potential include *Salmonella, Coxiella burnetti* (causing Q fever), *Brucella* (causing brucellosis), *Leptospira* (causing leptospirosis), Murray Valley encephalitis virus and *Angiostrongylus cantonensis* (causing neurological disease). Pathogens significant to livestock include *Neospora caninum*, porcine parvovirus, *T. gondii* and *Brucella* (all causing reproductive failure) and *E. granulosus*.

While the greatest potential disease threat from vertebrate pests may be from exotic outbreaks such as foot-and-mouth disease, many significant pathogens currently occur in pest animals in Australia. The presence of such a wide range of pathogens emphasises the need to effectively manage populations of invasive animals to avoid the spread of disease into livestock, native species or people. Increased surveillance of feral populations for significant disease organisms would also be prudent.

Biography: Wendy Henderson works as coordinator and project leader for the Detection & Prevention Program in the Invasive Animals Cooperative Research Centre (IA CRC) in Canberra, Australia. She holds a PhD in molecular biology and has a special interest in biosecurity issues relating to wildlife disease and vertebrate pest management. She has previously conducted lab research on genetic engineering of crops, and desktop research on various biosecurity-related projects for government and the IA CRC.

Grapevine Phylloxera: genotypic diversity and implications for management of incursions

Kevin Powell, Carolyn J. Trethowan and Ginger A Korosi, *DPI Victoria*

Grapevine phylloxera is present in most grape-growing regions of the world and is considered the worlds worst grapevine insect pest as eradication has so far proved elusive. In most countries phylloxera is managed through the use of phylloxera-resistant planting material. In contrast in Australia, where distribution of the pest is geographically limited phylloxera is managed primarily through quarantine and to a lesser extent through the use of resistant rootstocks. Phylloxera is contained within designated quarantine zones through the use of a range of protocols designed to minimize the risk of transfer between phylloxera infested and uninfested zones. Whilst previous genetic diversity studies have characterised 83 genotypes within Australia systematic characterization of potentially 'exotic' phylloxera genotypes from overseas is still required. The virulence levels of different clonal lineages is affected by host plant genotype and environmental factors. Systematic triphasic screening of clonal lineages in Australia using laboratory, glasshouse and field systems has indicated that rootstock recommendations would be more resilient and potentially aid eradication if clonal lineage of the pest species were considered. Preliminary studies on the effect of temperature and humidity using specific phylloxera clones have also indicated that the development of effective quarantine and surveillance protocols needs also to consider carefully the interactions between the pest and its environment.

Biography: Dr Kevin Powell leads the DPI-Victoria phylloxera research program and has over 15 years experience in Hemipteran physiology and management. He coordinated the inaugural International Grapevine Phylloxera Symposium held in Melbourne in 2000. Currently his research focuses on quarantine, detection and post-incursion management of grape phylloxera in Australia. The research

team, under his leadership, has focused on the development of novel early detection techniques and scientific validation of quarantine protocols and was awarded the Daniel McAlpine Outstanding Achievement Science Award in 2007 for phylloxera research.

Building resilience into the sugarcane agroecosystem: preparing for *Chilo sacchariphagus* in South Africa

Stuart Rutherford, *South African Sugarcane Research Institute* and Des Conlong, *South African Sugarcane Research Institute and Department of Conservation Ecology and Entomology, Stellenbosch University*

With increased travel between countries and encroachment of crops into previously undisturbed habitats, the incursion of new pests into sugarcane becomes increasingly likely. It has been shown that on continents in particular, insect pests of sugarcane are generally of local origin, with few introductions, while on islands the opposite is true. The African stalk borer *Eldana saccharina*, which before sugarcane became a crop in Africa, lived in wetland sedge and associated grassland habitats, illustrates this. In South Africa it has been continually present in sugarcane since the 1970's, as sugarcane increasingly became part of these habitats.

Other potential pests are present in these habitats that cover large areas spanning frontiers. Sugarcane has become a common denominator, providing a common resource for insects now adapted to it, and a large potential one for insects that may become adapted. Whilst *E. saccharina* invaded sugarcane from surrounding wild hosts, the Asian sugarcane borer *Chilo sacchariphagus* clearly shows how pests can be transported between continents. This insect arrived in Mozambique in the 1990's and once established, quickly attained pest status.

Faced with dual pathway incursion threats from indigenous and exotic insects we are now committed to 'building resilience to invasion into our agroecosystems, rather than building walls around them' (Waage and Mumford, 2008). To achieve this a refocusing of control efforts into a bio-intensive integrated pest management approach is necessary. Bio-intensive IPM is based on holistic agroecosytem interactions and marries conventional control options with ecologically based new technologies such as stimulo-deterrent diversion and enhancement of natural enemies through habitat management. It depends on knowledge about insects, their symbionts, pathogens, natural enemies, plant reaction to attack, endophytes and interactions between all of these being combined to develop IPM in an environmentally friendly manner.

Waage, JK and Mumford, JD. (2008). Agricultural Biosecurity. Phil.Trans.R.Soc. B 363, 863-876.

Biography: Stuart is a plant pathologist and an entomologist by training and currently manages the Crop Protection Programme at the South African Sugarcane Research Institute. He has a BSc degree from Reading University in England, a PhD from the University of Natal in South Africa and more recently an MBA from Cardiff Business School in Wales. His research interests are diverse, ranging from carbon sequestration in soil to the transcriptomics of indirect defence in plants against pests. Along with Des Conlong a collaborative project will soon begin with the aim of establishing a DNA barcode database of Saccharum pests and their parasitoids.

Risk analysis for Surra in Australia: some pieces of the puzzle

Kirsty Moynihan, Lee F. Skerratt, M.Odwell Muzari, T. Duran, L.A. Fitzpatrick, *School of Veterinary and Biomedical Sciences, James Cook University* and Rhonda E. Jones, *School of Marine and Tropical Biology*

Surra is an example of a disease that doesn't occur in Australia and we'd like it to stay that way. So how do we assess the risk of entry and spread? And how do we determine factors useful for containing and/or eradicating the disease, when it doesn't exist here and the environmental and host factors important to its epidemiology are quite different to those in countries where it already occurs? What information is useful for scenario modelling and how do we extrapolate sparse data over wide & diverse geographic areas?

A recent independent review into Australia's biosecurity and quarantine arrangements (The Beale Review) advocated for the development and maintenance of risk-based strategies for comprehensive post-border monitoring and surveillance program for national priority exotic pests and diseases. Such strategies are obviously constrained by resources and logistics, especially in remote locations such as far north Queensland.

Using some recent data on insect vectors of surra as an example, we suggest some avenues for analysing risk and how this might assist targeting of surveillance and assessment of impact analysis. Surra is known to affect almost all mammalian species. This means that hosts for the disease are found ubiquitously in the Australian environment. Therefore aspects of the epidemiology, such as distribution and abundance of the vectors and their feeding preferences, if any, may influence the establishment and spread of disease. Results and implications of analysis of host feeding of tabanids caught over a wide geographic area of northern Queensland are examined.

Some aspects of control strategies are also discussed in relation to data on the daily activity patterns of the insect vectors, and how knowledge of their feeding patterns might influence advice on avoiding infection, especially in companion or high value animals, if the disease were to establish in Australia.

Biography: Kirsty van Hennekeler completed her PhD on ecology of tabanid flies and their potential as vectors of Trypanosoma evansi in 2007. She has worked for the Department of Agriculture and Food, Western Australia, in biosecurity policy and product integrity roles for the last 2 years.

Emerging disease threats to protected cropping vegetable and ornamentals

Len Tesoriero, Leanne Forsyth, *NSW Department of Industry Investment, EMAI*, Denis Persley and Cherie Gambley, *Queensland DPI&F*

Plant diseases can cause significant losses to greenhouse vegetable and ornamental crops. Worldwide there has been increased reporting of new diseases and pathogen spread to different geographical areas. This is partly due to improved molecular and serological diagnostic techniques that have helped distinguish variant pathogenic strains or enabled new pathogen species to be characterised. Increased world trade and travel, specifically movement of people, seed, vegetative propagating material and plant products, implicitly elevate the risk for pan-geographic spread of plant pathogens. Certain viruses and bacteria spread with their respective arthropod vectors. In rare cases inter-continental spread occurs when these vectors are carried long distances with air currents. However, spread of pathogens and their vectors is more likely with movement of vegetatively propagated plants, tissue-cultured plantlets, plant products and nursery stock. Introducing production of vegetable and ornamental crops to new geographical areas has led to the emergence of newly described viruses, such as an increasing number and types of viruses and their respective whitefly vectors. Plant diseases also affect natural ecosystems. *Phytophthora ramorum* causes leaf spots and shoot blight in camellias and rhododendrons but is also responsible for sudden oak death of mature trees in the USA and Europe. It is likely that this pathogen had spread with nursery stock from Europe to North America in the last decades. Recent studies in the USA have seen its host range ever increasing.

Plant biosecurity is therefore important for protecting commercial production of plant products as well as the natural environment. Meeting phytosanitary standards has increasingly become a primary consideration for accessing international and sometimes, interstate markets.

Understanding each emergency plant pest's biology is the key to implementing sound biosecurity safeguards and minimising the risk of them entering Australia.

Biography: Len Tesoriero is a Plant Pathologist and the Industry Leader for Greenhouse and Ornamental cropping with the NSW Department of Industry Investment. He has over 28 years experience in diagnostic plant pathology of a wide range of commodities as well as managing several research projects developing integrated management strategies for diseases of horticultural crops. Len has a particular interest in plant viruses affecting vegetable crops and taxonomy of the Oomycete genus, *Pythium*.

A proactive approach: risk assessment for the plant pathogen *Xylella fastidiosa*

Anne Rathe, *Cooperative Research Centre for National Plant Biosecurity and Charles Sturt University*, Lee Pilkington, *Department of Industry and Investment, Gosford Primary Industries Institute*, Geoff Gurr, *E. H. Graham Centre for Agricultural Innovation, Charles Sturt University* and Mark Hoddle, *Applied Biological Control Research, Department of Entomology, University of California*

Vectored by insects, predominantly *Homalodisca vitripennis* Germar (Hemiptera: Cicadellidae), *Xylella fastidiosa* Wells (Xanthomonadales: Noctuoidea) is a xylem-limited plant pathogenic bacterium that causes diseases in numerous host species including crops, ornamentals and weeds. *Xylella fastidiosa*, not yet detected in Australia, is native to the Americas and is considered to be highly invasive. Australian climatic conditions are favourable for establishment and the wine and table grape industry is particularly concerned about the arrival of *X. fastidiosa* because of the economic impact on this important Australian commodity. Past *X. fastidiosa* invasions have demonstrated the need for rapid detection and containment of an incursion which requires knowledge of pathogen host plant species and their subsequent monitoring. In Riverside, California, Australian native plants that had been exposed to a high level of vector and pathogen pressure were assayed for *X. fastidiosa* presence. Petiole samples were taken from both Australian native nursery plants and individual Australian natives identified during a survey of Southern California and tested for the presence of the pathogen using PCR and culturing. The results to be presented indicate the host status of several Australian native plant species and whether they may act as reservoirs from which further spread of the pathogen can take place should it reach Australia. The information gained from these surveys has been compiled with past survey findings to build up a reference database for continued *X. fastidiosa* monitoring. The implications of these findings will be discussed and placed in an Australian invasion context.

Biography: Anna is originally from New Zealand where she graduated from the University of Otago, Dunedin with an honours degree before moving to Australia. She has been based at the NSW Department of Industry and Investment, Gosford for the past year where she is completing a PhD through Charles Sturt University. Her PhD project is based on a plant pathogen and its insect vector with a particular focus on the risk that these organisms pose to Australia. She is supported by the Cooperative Research Centre for National Plant Biosecurity and the E H Graham Centre.

Risk factors for the infection of horse premises by equine influenza in New South Wales

Simon Firestone, Kathrin Schemann, Jenny-Ann Toribio, Michael Ward and Navneet Dhand, *University of Sydney*

The outbreak of equine influenza virus (EIV) in Australia in 2007 provided a rare opportunity to investigate the effectiveness of on-farm biosecurity measures and the in preventing the spread of a novel pathogen in a predominantly 'naïve' population. We conducted a case-control study involving 200 horse premises from highly affected regions of New South Wales (NSW), to investigate risk factors for the spread onto a premises, in particular, non-compliance with biosecurity measures as recommended to horse owners by the NSW Department of Primary Industries (DPI).

The study was restricted to the first seven weeks of the 2007 EIV outbreak in NSW, a period prior to vaccination and the relaxation of certain movement restrictions. Case and control premises were selected from the DPI laboratory testing dataset. Questionnaires were designed to obtain information about potential risk factors and confounders, and had specific activities to aid respondents' recall. Interviews were conducted with horse owners and managers on 100 case and 100 control properties between July and November 2009.

Amongst premises with accurate address and telephone details a response rate of 85.5% was achieved. Of the 200 premises interviewed, most were small acreages with pleasure horses (47%), farms (19%), and horse training facilities (18%). The median premises area was eleven acres, and median number of horses per premises was five.

Detailed results from logistic regression analyses will be presented at the conference. Based on preliminary univariate analyses, factors strongly associated with infection of a premises include: close proximity to an infected property, and smaller area premises with small numbers of horses. Certain biosecurity practices by horse owners and managers were strongly associated with a reduced risk of infection.

Acknowledgements: This research was jointly funded by Rural Industries Research and Development Corporation (RIRDC) and Australian Biosecurity Cooperative Research Centre for Emerging Infectious Diseases (ABCRC).

Biography: Simon is a veterinarian and epidemiologist, currently undertaking a PhD at the University of Sydney, with support from the ABCRC and the RIRDC. Since graduating from Melbourne University in 2000, he has worked in private veterinary practice and undertaken several postings in South-east Asia. In 2007, he completed his Master of Applied Epidemiology studies at ANU working on the surveillance of zoonoses and human seasonal influenza at the Department of Health and Ageing, Canberra. More recently, Simon has consulted for the World Health Organization, establishing integrated surveillance for avian influenza in Indonesia, and building outbreak investigation capacity in Cambodia.

Relationships between H7 avian influenza isolates from the five poultry outbreaks (1976-1997) in Australia

Dieter Bulach, David B. Boyle, Lee Trinidad, *CSIRO Livestock Industries Australian Animal Health Laboratory*, David Spiro, Rebecca Halpin, *J. Craig Venter Institute* and Daniel Janies, *Department of Biomedical Informatics, The Ohio State University*

The full genome sequencing of 11 Australian and H7Nx avian influenza A isolates has enabled the comparison of sequences from each of the genome segments to other sequenced H7Nx avian influenza A. The inference of phylogenetic relationships for each segment has been used to develop a model of the natural history of these viruses in Australia. The Australian H7 hemagglutinins form a monophyletic clade, consistent with the long-term, independent evolution in geographic isolation. Based on the analysis of the other available H7 hemagglutinins sequences, three other regions of long-term independent evolution were confirmed, these included Eurasia (Africa, Europe and Asia), North America and South America. Analysis of datasets of H7N1, H7N3, H7N7 neuraminidase sequences revealed congruent relationships indicating a similar pattern of geographically constrained independent evolution for these neuraminidase sequences. This pattern of geographically constrained independent evolution is apparent for each of the six remaining segments among the Australian isolates. These data in conjunction with the occurrence of five different combinations of neuraminidase subtypes (H7N2, H7N3, H7N4, H7N6, H7N7) among the 11 Australian isolates provides an indication that viral genetic diversity is maintained locally within Australia and that there is rare genetic exchange between virus from Eurasia (probably via Asia) and Australia. These viral relationships have been used to speculate on the role of various wild bird populations in the movement of influenza into and out of Australia.

Biography: Dieter has been working at AAHL for just over two years and is currently involved in projects on bat genomics as well as the development of methods for high throughput sequencing of viral genomes. Prior to commencing at AAHL Dieter was involved in several bacterial genomics projects (in a time when that was significant!). Dieter did his PhD at the University of Melbourne on the molecular analysis of baculovirus diversity and then spent more than years working with Professor Ben Adler on primariy on aspects *Leptospira* genomics

Reducing the impact of eradication for exotic grapevine pathogens

Mark Sosnowski, *South Australian Research and Development Institute*, Bob Emmett, *Department of Primary Industries, Victoria*, Wayne Wilcox, *Cornell University* and Trevor Wicks

Eradication of exotic grapevine diseases can incur significant costs to growers and the industry using current strategies which include complete removal of affected and suspected vines. Alternative strategies need to be developed which optimise the process of eradicating the pathogen while minimising the economic cost of returning the crop to its previous quality and production levels. An endemic fungal disease of grapevine, black spot (*Elsinoe ampelina*), was used as a model in Australia to develop a drastic pruning eradication strategy for the exotic fungal disease black rot (*Guignardia bidwellii*). A simulated eradication was conducted during winter 2008 which involved removing all foliage and cordons from infected grapevines and raking and removal of debris from the vineyard floor.

Assessment in the following summer revealed reoccurrence of black spot symptoms on 11% of treated vines, limited to shoots growing from the trunk up to 20 cm above the ground. The use of sentinel vines and a bioassay indicated that symptoms were caused by inoculum produced from vine debris remaining on the ground beneath the vines. As a result, the disease eradication protocol was modified to include removal of lower shoots and the use of mulch straw on the vineyard floor. The revised protocol will be applied in the second year of the model eradication trial in Australia and is currently being validated for black rot in an infected vineyard in the USA, where the disease is endemic. Relative to current strategies, this research has potential to save the Australian wine industry over $18 million in lost production and vineyard re-establishment if there is an exotic disease incursion.

Biography: Dr Mark Sosnowski is a plant pathologist with the South Australian Research and Development Institute. Graduating with a B. Ag. Sc. from the University of Adelaide, he commenced working for SARDI in 1997 and completed a PhD in 2002, studying the epidemiology and management of blackleg disease of canola. Since 2003, Dr Sosnowski has been responsible for research on trunk diseases of grapevines. Since 2006 he has also led Cooperative Research Centre for National Plant Biosecurity research which aims to optimise eradication strategies for exotic pathogens on perennial crops, concentrating his own research on the eradication of grapevine pathogens.

Tall Wheat Grass and other invasive salinity 'solutions'

Carol Booth, Geoff Carr and Tim Low, *Invasive Species Council*

Invasive pasture plants are promoted in southern Australia for salinity control and productive use of saltlands. In Victoria, one of the promoted and subsidized salinity 'solutions', Tall Wheat Grass (*Lophopyrum ponticum*), could become one of the state's worst weeds.

A government risk assessment found that Tall Wheat Grass could invade 10.4 million ha of Victoria and its invasion of saltmarshes should be listed as a threatening process. But because of its pasture values, the assessors recommended against weed declaration.

We have compiled records of naturalization and documented threats posed by Tall Wheat Grass. It has an extraordinary ecological amplitude, invading saltmarshes, wetlands, grasslands, estuaries, coastal cliffs, waterways, roadsides and some woodlands, and tolerating drought, frost, salinity, alkalinity and waterlogging.

The extent of salinity and its costs to Victoria are far outweighed by the threat and costs of weeds promoted as salinity solutions, yet the weed risks are mostly ignored or downplayed. Of 23 pasture species promoted by the Cooperative Research Centre for Future Farm Industries for use on saltlands (on their *Salt Genie* website) more than 60 per cent are environmental weeds.

Projects are under way to domesticate new pasture species and develop new cultivars to tolerate harsher conditions (drought, salinity and acidity) and grow in lower rainfall areas. Of 190 prospective pasture species for discharge or recharge sites identified by agronomists in three recent reviews, about half are already weeds in Australia and two-thirds are weeds overseas. Although the CRC for Future Farm Industries now conducts weed risk assessments on proposed new releases, standards are so low that plants identified as 'high risk' can be released with voluntary guidelines.

We analyse institutional failings that lead to the promotion of environmentally risky solutions for salinity, and make recommendations to investigate and protect ecosystems at risk from invasion, prevent further harm and address systemic problems.

Biography: Carol Booth has worked as an advocate for nature conservation for about 15 years with the current focus on achieving better laws and policies to protect the Australian environment from invasive threats - with the Invasive Species Council, an environmental NGO. She also has an academic background in both science and environmental philosophy

Trapping strategies for Mediterranean fruit fly in Australia

Francis De Lima, *Department of Agriculture and Food Western Australia* and S. R. Poogoda

Area freedom from Mediterranean fruit fly (MFF) is validated through continuously monitoring a static array of traps placed 400 metres apart in a grid over a specified fruit fly exclusion zone (FFEZ). To reduce costs and maintain efficiency, a dynamic system was devised and tested over two seasons to provide a higher level of statistical confidence in proving area freedom. Traps were deployed (in towns and on farms) in 12 sites at 4 geographical locations in Western Australia. Fruiting hosts in a 200 metre radius around each site were mapped and phenology and fly numbers recorded at each trap check. The sites were chosen based on previously known population densities: Donnybrook: <2/flies/trap/week; Manjimup: <1/fly/trap/week; Pemberton: 0/flies/trap/week; and Kununurra FFEZ: 0/flies/trap/week.

In two seasons 2007-09, in Donnybrook significantly higher fly numbers were recorded in individual dynamic traps and a higher percentage of dynamic traps captured MFF (34.4% dynamic: 17.4% static (P=0.004)) showing that the probability of catching a single MFF in a dynamic trap is 17.5% higher than it is in a static trap grid. The work proved that 40 dynamic traps give an equivalent estimate of the population as 100 static traps. In Manjimup Town 4.56 % of dynamic traps captured MFF compared with 0.04% of static traps (P=0.781); no flies were detected in orchards. In Pemberton Town (an area with no MFF breeding population) only 2 itinerant flies were captured in 2007-08 and an introduced population was detected in 2008-09; no detections in orchards. In Kununurra (a MFF free area) 12 dynamic traps proved area freedom with the same accuracy as a static grid of 40 static traps.

These results prove that a dynamic targeted monitoring system is effective and may be deployed at lower operating cost in proving and maintaining area freedom.

Biography: Dr De Lima has worked for 25 years internationally and in Australia on the ecology and area wide management of the Mediterranean fruit fly, developing monitoring systems for area freedom and validation of eradication of outbreaks.

Knowledge Stream Abstracts

(in presentation order)

The Australian Biosecurity Intelligence Network – a Commonwealth funded infrastructure initiative

Dr Joanne Banyer, Dr Bronwyn Morrish and Steve McMahon, *Australian Biosecurity Intelligence Network*

The Australian Biosecurity Intelligence Network (ABIN) is a Commonwealth funded National Collaborative Research Infrastructure Strategy initiative being established to address one of Australia's infrastructure priorities - the need for a *Networked Biosecurity Framework*.

Throughout Australia, over 60 agencies and institutions are involved in biosecurity research and delivery of biosecurity outcomes. Without mechanisms for national cross sectoral collaboration, effort is fragmented, draws upon limited resources, and is often duplicated. Collaboration within sectors is highly variable and collaboration between sectors is sometimes rudimentary.

To address these issues, ABIN's mission is to generate a whole of biosecurity national collaborative capability in research, surveillance, and response that will reduce the impact of disease and invasive species on Australia.

To achieve this ABIN will -

- Provide a shared virtual workspace where researchers, operational groups, managers and policy makers can share information and collaborate across organisations, jurisdictions and sectors in biosecurity.
- Develop a portal that provides researchers and others involved in surveillance preparedness and response with a "one stop shop" access to data and information.
- Create a culture of connectivity both in data sets, communications and collaborative thinking.
- Develop and provide access to tools and expertise that facilitate data linkages.
- Provide a level of access that enables real time deposition and access to data housed within ABIN or retained by the data owner.
- Develop a suite of tools that enable enhanced analysis of information and data. It will be a centre of excellence in skills associated with these tools. The tools will support all types of biosecurity data analysis, including modelling, mapping, spatial temporal analysis and risk assessment.
- Result in the development of generic skills – modelling, mapping, risk assessment, epidemiology, experimental design and social sciences related to population dynamics.
- Provide the infrastructure for a virtual training environment.
- Develop regional relationships with biosecurity networks in South East Asia to enhance the two-way flow of disease intelligence to enhance biosecurity in our region.

During the establishment of ABIN, intelligence networks and virtual collaboration capabilities that are centred on areas of national biosecurity need in each sector will be generated through a series of Proof of Concept Projects. Also, local or regional biosecurity activities that would be strengthened in the national interest from provision of scientific support to users of the ABIN system in areas such as predictive analysis, surveillance, modeling and relevant epidemiology, will be established in 'Test Sites'.

Biography: Dr Joanne Banyer is the Chief Executive Officer (CEO) of ABIN who holds an Honours degree in microbiology and a PhD in genetics and immunology. She worked as a genetic and infectious disease researcher at the Queensland Institute of Medical Research and at the John Curtin School of Medical Research and has held a range of start-up roles in Attorney Generals, including as Science Advisor, support to establishment of a Corporate Executive Research and Development Committee, and established the Chemical, Biological, Radiological, Nuclear and Explosives Terrorist Weaponry Directorate.

Dr Bronwyn Morrish is ABIN's Biosecurity Project Manager with responsibility for managing ABIN's Proof of Concept projects. She has a background in biological sciences and policy, having worked recently as a technical advisor for the Australian Federal Police and as a project officer within the Commonwealth Department of Health and Ageing working on biosecurity initiatives, including avian influenza and laboratory preparedness.

Mr Steve McMahon is the IT Capability Manager of ABIN who holds an Honours degree in Physics and Masters degree in aerospace engineering. He has worked as a scientific programmer then as a data services expert at the Australian National University Supercomputer Facility and the Australian Research Collaboration Service.

Improving biosecurity outcomes through networking Australia's Wildlife Health data with the Australian Biosecurity Intelligence Network

Dr Karrie Rose, *Taronga Zoo*

The critical need to have systems in place to rapidly detect, diagnose and respond to emerging diseases in wild and feral animal populations in Australia was recognised through the National Collaborative Research Infrastructure Strategy as a priority proof-of-concept project for establishment of the Australian Biosecurity Intelligence Network (ABIN). The Wildlife and Invasive Species project aims to establish access to an intensive and extensive repository of wildlife heath data and images, as well as the ability to use these data in a collaborative space to facilitate national, regional and international research, education, surveillance and response.

The project will also test on-line analytical tools to not only enable early identification of new and emerging diseases but also documentation and communication (including disease alert, tracking, and mapping) and predictive modeling. A fully national web based wildlife health surveillance system (eWHIS) is an anticipated outcome.

In addition, through ABIN, the wildlife sector will establish a national system of whole slide imaging to enable creation of digital images of glass microscope slides to support the diagnosis of unknown, rare and emerging diseases in wildlife. This digital slide scanning resource will be accessible by different sectors operating in the biosecurity space to assist peer-peer visual communication among the national pool of researchers and diagnosticians and to enlist global expertise to solve complex problems, as well as enhancing training and quality assurance programs.

Biography: Dr Karrie Rose (D. V. M, D. V. Sc) is the Manager for Australian Registry of Wildlife Health, where she has focused on applied comparative pathology, disease investigation in free ranging wildlife, and the development of wildlife health information management systems to facilitate disease surveillance, research and education.

The Australian Registry of Wildlife Health is a program of the Taronga Conservation Society Australia. The Registry provides a diagnostic service for free ranging wildlife and is a wildlife health resource centre. The Registry has a broad range of stakeholders nationally and internationally, including state and commonwealth departments of agriculture, human health and environment, universities, zoos, museums, and many national wildlife health centres overseas.

Building a virtual microscopy laboratory network through the Australian Biosecurity Intelligence Network

Dr Marc Kabay, *Department of Agriculture and Food, Western Australia*

The creation of a virtual microscopy laboratory network is a proof-of-concept project of the National Collaborative Research Infrastructure Strategy to establish the Australian Biosecurity Intelligence Network (ABIN) and came from the veterinary pathology sector as a means to overcome issues associated with geographical and professional isolation, managing disaggregated information from a variety of sources, and under-resourcing in technology to share information and collaborate. There is a real need to share information more efficiently, move the maintenance of knowledge repositories from the domain of the individual to the domain of the collective and to mentor the next generation of pathologists more effectively.

In the initial phase of this project to network veterinary pathologists using the virtual microscopy laboratory network, operators will be able to:

- Capture and share real time microscope images in a peer-to-peer or group context.

- Communicate and collaborate, from their work place, in a virtual environment and shared workspace, using video-conferencing and collaboration platforms.
- Access, share and add to information in knowledge repositories for animal-disease reference material, standards for testing, or research specific activities.
- Analyze laboratory accession data using a variety of tools including mapping technologies.

Through the knowledge repository, the project will provide information to questions such as "What is the likely diagnosis for this case, what is the current understanding of pathogenesis of this disease, what test confirms the diagnosis, what are the gross and microscopic features of this disease, what do the lesions look like, how common is this disease, where does it occur and does it have a seasonal occurrence?"

The project will network sites around Australia with the necessary components to allow collaboration within and between sectors, including the aquatic, wildlife and plant sectors.

The components will include a microscope camera connected to a workstation with access to video-conferencing, collaboration space and a web portal to integrated knowledge repositories. The workstations will be deployed in multiple facilities allowing access for users from across sectors. It is envisaged that this infrastructure investment will create a critical mass of participants to contribute to and evaluate the system; and justify future co-investment if it proves successful and beneficial.

Biography: Dr Marc Kabay is a senior Veterinary Pathologist with the Animal Health Laboratories of the Department of Agriculture and Food, Western Australia. He is active in animal disease surveillance through his role as a diagnostic pathologist. He also provides policy advice for information management for biosecurity projects within government at a state and national level, in the areas of disease surveillance and emergency disease response. In addition, he has experience in information system project management and system design including; veterinary laboratory based systems, agricultural client information management systems and applications for disease data analysis and modelling.

Remote microscopy: diagnostics, training and beyond

Michael Thompson, *Cooperative Research Centre for National Plant Biosecurity and CSIRO Entomology*, Gary Kong, *Cooperative Research Centre for National Plant Biosecurity and Primary Industries and Fisheries Dept of Employment, Economic Development and Innovation,* A Carmichael, *Cooperative Research Centre for National Plant Biosecurity and School of Natural Resource Science, Queensland University of Technology* and Darren Peck, *AQIS Operational Science Program*

Remote Microscopy (RM) was developed in response to the biosecurity threats posed by Emergency Plant Pests (EPPs) and other pests and pathogens. RM overcomes the time and distance that exists between these threats and the experts that identify them to provide a valuable diagnostic communication tool. RM is unique in that it is a web-based *real time* diagnostic tool that allows non-experts to rapidly and easily collaborate with experts to identify pest specimens *instantly*, and so save money and resources. Rapid identification, particularly of exotic pests, is critical to biosecurity response and subsequent incursion management. Centred around microscopes connected to Nikon web-based digital cameras, RM provides a real time, affordable, widely accessible tool that connects experts and specimens, regardless of location. The RM network is launched from the Pest and Diseases Image Library (PaDIL), and acts as part of a one-stop diagnostic shop that also includes the PaDIL, the Plant Biosecurity Toolbox (diagnostic database) and the Biosecurity Bank (genetic information). RM effectively aids in identifying pests in quarantine settings providing both economic and biosecurity benefits. In addition, applications of RM domestically and internationally present immense value in training. The RM network will play a part in the training of operational personnel in diagnostic and quarantine roles or in general education settings in our national collections, museums and universities. RM has the potential to tighten Australia's biosecurity network by providing a powerful means of training and up-skilling remotely as well as facilitating immediate identification of biosecurity threats. RM technology is currently in regular use in quarantine settings in both the Australian Quarantine and Inspection Service (AQIS) and the New Zealand Ministry of Agriculture and Forestry (MAF) and is proving its worth in training and in interception identifications. This conserves/leverages resources for AQIS, MAF and their clients. RM will also build on existing databases and resource pools such as those based in the PaDIL. This will be achieved through the application of dynamic software to allow authors to develop tools such as Lucid keys and other elements of existing databases. Recording of live video

feeds to PaDIL via RM and the subsequent availability of this and other PaDIL based data to PDAs and podcast applications will also be developed.

Biography: Michael is working to establish a Remote Microscope network in Australia, New Zealand and South East Asia. From ANIC in Canberra, Michael is directing the growth of the network as well providing support and training for users and experts.

A biosecurity framework for harmonisation of knowledge

Debra Riddell, *Department of Agriculture Fisheries and Forestry*

The BioSIRT (Biosecurity Surveillance, Incident Response and Tracing) application provides a mechanism for capturing structured data used in the management of routine and emergency response biosecurity activities. BioSIRT has been developed cooperatively by the Commonwealth, state and territory governments and implemented nationally. It also provides the technical environment for achieving national consistency of the information collected.

In addition to BioSIRT, related and less-structured biosecurity data is collected and collated by a number of other applications such as PaDIL (Pest and Diseases Image Library).

It is envisaged that both the structured and unstructured biosecurity data may be harmonised in such a way that access to all information can be made available for a variety of uses - market access, targeted research, improved risk analysis and managing social and environmental outcomes being just a few examples.

BioSIRT uses a contextual framework to harmonise structured data across animal and plant health sectors and this method is being trialled using fruit fly information collected nationally.

This presentation will describe the BioSIRT contextual framework and its application to the cross-jurisdictional and broader collection of fruit fly related information. Actual implementation issues and outcomes will be discussed as well as opportunities for further use of the harmonised information and the tools that may be applicable.

Biography: Debra Riddell was appointed as the National BioSIRT Program Manager in July 2007. She came to the Program towards the end of the development phase and her primary focus has been on implementation across all Australian jurisdictions. Debra has over 20 years experience in software development and government project management. Her assignments have included the structural reform of aged care for the Department of Health and Ageing, coordination of Palmer Programme initiatives at Department of Immigration and working with the World Intellectual Property Organisation (WIPO) on behalf of IP Australia. She has a master's degree in Business Administration and is a member of the Project Management Institute (PMI).

The Office of the Chief Veterinary Officer's (OCVO) scanning report – an approach to identifying emerging issues for animal health management in Australia

Belinda Wright, Peter Black, Jill Mortier and Peter Beers, *Australian Government Department of Agriculture, Fisheries and Forestry*

The Office of the Chief Veterinary Officer (OCVO) in the Australian Government Department of Agriculture, Fisheries and Forestry, produces a semi-regular report – the OCVO Scanning Report – that aims to identify emerging issues pertinent to animal health in Australia. The report is produced using strategic foresight methodologies, particularly environmental scanning. It is focused on identifying issues in the medium to long term, to allow the OCVO to position itself to respond appropriately and effectively to the identified threats and opportunities. Importantly, the report does not simply aggregate information; it focuses on analysis and interpretation. This approach to intelligence gathering and analysis within OCVO has developed over several years, driven by the need for more effective tools to deal with the increasing complexity of problems in the animal health arena and the increasing rate of change in the global environment. The report is produced by a small team and is circulated within Australia to government and industry groups, and to several overseas agencies. As a result of the interest shown in the report it is now provided to a much wider audience than was originally intended.

The paper describes the origins of the report, how it is produced, difficulties and challenges associated with its production, critical success factors, lessons learned, and some successes achieved with this approach.

Biography: Belinda is a qualified veterinarian with post-graduate qualifications in aquatic veterinary studies and clinical epidemiology. Belinda joined the Australian Government Department of Agriculture, Fisheries and Forestry in 2001and has worked on biosecurity policy development for aquatic animal products, the management of national aquatic animal health programs (including AQUAPLAN and AQUAVETPLAN), the development of international standards for aquatic animal health and the department's response to emergency aquatic animal diseases of national significance. Belinda's current work involves intelligence gathering and the identification of emerging issues in the management of animal health.

Office of the Chief Veterinary Officer's (OCVO) animal health scanning activities: so far so good, where to from here?

Belinda Wright, Peter Black, Jill Mortier and Peter Beers, *Australian Government Department of Agriculture, Fisheries and Forestry*

The Office of the Chief Veterinary Officer's (OCVO's) animal health scanning activities are undertaken by a small team within the Australian Government Department of Agriculture, Fisheries and Forestry, who have been formally tasked with developing a system for gathering and reporting on intelligence covering emerging issues related to the management of animal health. The system developed uses environmental scanning to identify relevant emerging issues, relying on existing resources, and minimal staff time, to address this broad remit. (Environmental scanning is a method for the early identification of emerging issues and typically relies on systematically seeking and exploring information from a range of domains.) This modest project has been successful, with the intelligence reports produced (OCVO Scanning Reports) now distributed in Australia and overseas and apparently highly sought-after by a range of other government, industry and private stakeholders.

Although the developed system works, there remains considerable scope to broaden the breadth and depth of issues covered, and to involve other groups in the scanning activities. To investigate ways in which this might be achieved, the department commissioned four consultancies. These covered software options for more effectively and efficiently gathering, analysing, managing and sharing information; a review of how other agencies conduct similar intelligence activities; a survey of Australian stakeholders to gauge their understanding of, and interest in, environmental scanning and foresight activities; and, a review of the use of stakeholder networks for environmental scanning. Together, the findings from these consultancies provide valuable insights and lessons for all those interested in animal health intelligence-gathering activities, particularly for the development of collaborative efforts among individuals and organisations.

Biography: Belinda is a qualified veterinarian with post-graduate qualifications in aquatic veterinary studies and clinical epidemiology. Belinda joined the Australian Government Department of Agriculture, Fisheries and Forestry in 2001and has worked on biosecurity policy development for aquatic animal products, the management of national aquatic animal health programs (including AQUAPLAN and AQUAVETPLAN), the development of international standards for aquatic animal health and the department's response to emergency aquatic animal diseases of national significance. Belinda's current work involves intelligence gathering and the identification of emerging issues in the management of animal health.

Biosecurity Cyberinfrastructure for Surveillance, Modeling and Risk Analysis

Roger D Magarey, *Center for Integrated Pest Management/ North Carolina State University*, Joe Russo, *ZedX inc* and Manuel Colunga-Garcia, *Center for Global Change and Earth Observations/Michigan State University*

Biosecurity activities fall along a continuum that spans from offshore activities to the management of newly established exotic pests. Both costs and information needs increase dramatically as an exotic pest moves in time along the biosecurity continuum. To help meet these information needs, we

propose the development of a cyberinfrastructure to link biosecurity agencies, researchers and stakeholders, including industry and the public. The United States National Science Foundation (US NSF) Blue Ribbon Committee Report in 2003 defined a cyberinfrastructure as a virtual organization of information exchange based on computers, software, and communication. Our vision of a biosecurity cyberinfrastructure grew out of our earlier participation in the development of the US Department of Agriculture (USDA) Soybean Rust website (now called the ipmPIPE) and the NCSU APHIS Plant Pest Forecasting (NAPPFAST) system. The NAPPFAST system today contains functionality for pest surveillance, modeling, risk analysis and the targeting of high risk pathways. Its "role-based" design allows users to access the system as observers, analysts and program managers, while pests are organized under management programs. The role and program structure allows for the sharing of information including data, commentary and model products within and between organizations. A cyberinfrastructure, as the next evolutionary step for the NAPPFAST system, would give users the capacity to create sophisticated risk maps, such as those that integrate climate and pathway models with host distribution and land use data. It would also give users the ability to analyze disparate information sources with the possible recognition of patterns of human-mediated pest invasions. Furthermore, with supporting research, the understanding of processes behind these patterns could facilitate mitigation measures (i.e. the monitoring of high risk areas). The presentation of a biosecurity cyberinfrastructure will conclude with a brief discussion on potential implementation barriers and on the role of industry in providing critical data sources.

Biography: Roger Magarey grew up on a pear orchard in the Adelaide Hills, Australia. He earned a Bachelors Degree in 1989 (University of Adelaide) and a Ph.D. in Plant Pathology 1999 (Cornell University). In 2003, Roger became a cooperator with USDA-APHIS-PPQ-CPHST in Raleigh, NC through the NCSU Center for IPM. Roger has developed the NAPPFAST system in collaboration with Dr Daniel Borchert of CPHST and Dr Joe Russo of ZedX inc. He has also worked on the Pest Information Platform for Extension and Education (PIPE) and PRA archival using the Global Pest and Disease Database.

Wildlife health information in Australia: bridging the gaps between wildlife and industry

Rupert Woods, Tiggy Grillo, *Australian Wildlife Health Network*, Chris Bunn and Lyndel Post, *Wildlife Health and Environment, Australian Department of Agriculture, Fisheries and Forestry*

Australia has one of the best biosecurity systems in the world. Identifying priorities for surveillance and coordination across jurisdictions can, however, be challenging especially in a federated system. This is especially so in the wildlife sector, where activities not only require coordination across jurisdictions, but also across multiple agencies, organizations and industries.

Since 2004, in response to the global avian influenza H5N1 pandemic threat, Australia has intensified its avian influenza virus surveillance activities. This paper presents the Australian National Avian Influenza Wild Bird Surveillance Program and discusses some of the challenges and benefits associated with better coordinating wildlife surveillance and information exchange. It highlights how wild bird surveillance has helped poultry biosecurity plans and shows how a coordinated program, involving States and Territories of Australia has assisted in maintaining laboratory influenza testing capability. As well as on-going preparedness for H5N1, these activities have also been important in Australia's recent response to equine influenza, and our on-going response to H1N1.

The paper will present solutions for Australia and concludes that though many good research and policy initiatives are occurring, Australia needs to continue to integrate wildlife health surveillance activities into national frameworks, better coordinate activities between agencies and recognise the mutual need for sustained direction and focus.

Biography: Chris Bunn and Lyndel Post are Principal Veterinary Officers with the Australian Department of Agriculture Fisheries and Forestry (DAFF). They manage a new program, "Wildlife Health and Environment", which has been formed within the Animals Division of the new biosecurity agency. Wildlife Health and Environment also administer Australia's Wildlife Exotic Disease Preparedness Program (http://www.daff.gov.au/animal-plant-health/emergency/wedpp), and the Australian Wildlife Health Network (www.wildlifehealth.org.au).

Rupert Woods and Tiggy Grillo work for the Australian Wildlife Health Network (Manager and Projects Coordinator). Its mission is to promote and facilitate collaborative links in the investigation and

management of wildlife health in support of Australia's human and animal health, biodiversity and trade. Core business for the Australian Wildlife Health Network is wildlife disease surveillance.

Building a global plant health alliance: the function and role of an integrated plant health information system

Trevor Nicholls, *CABI*

Worldwide as much as 40% of the food we grow is lost to pests and diseases, either in the field or during transport and storage. Increasing global trade flows and climate change are likely to accelerate the spread of known pests and give rise to new pathogens. In a world where food security is under increasing pressure, we need to lose less as well as grow more.

Farmers, extension staff, institutions and governments need access to accurate information to manage and plan for threats. Countries are keen to ensure that the products they are importing do not contain pests, pathogens or invasive species. Chemical, food and insurance companies are seeking to inform new product development and ongoing supply management.

Our research in these sectors suggests that no single organization provides comprehensive information, surveillance and management advice in this area, despite the high level of demand. Existing CABI services and products could provide the basis for such information. If enhanced and merged with third party resources, this could evolve into a powerful resource to monitor plant health plant health worldwide.

We will outline plans for the development of a global Plant Health Alliance (PHA). By providing relevant content from CABI and respected partners through a focused portal this will enhance the public good access of available information as well as exploiting business potential to become self-funding.

We will add proprietary information from an expansion of the Plant Clinic network that CABI has already established. This provides a unique global surveillance system through which geographically specific pest and disease reports can be filed in real-time from plant doctors operating in remote locations.

We are currently seeking inputs and partnerships to ensure that this proposed resource will be complementary to existing national and international organizations responsible for plant protection and biosecurity.

Biography: Trevor Nicholls joined CABI in 2005 and has restructured the organisation to deliver clearer strategic focus and customer orientation. CABI improves lives worldwide by providing information and applying scientific expertise. It delivers by helping the world lose less of what it grows.

Before CABI, his career covered 25 years experience of building international businesses in the life science industry, with major pharma, biotech and academic clients. He has broad experience of initiating change and restructuring organisations, ranging from start-ups to quoted companies. Trevor holds a BA and D.Phil in Biochemistry from the University of York and qualifications in Marketing (CIM) and Company Directorship (IoD).

Grains biosecurity aligns with dynamic communication and adoption industry programs for on-farm impact

Judy Bellati, *Primary Industries of South Australia Agriculture, Food and Wine*, *Lisa Sherriff*, *Department of Agriculture and Food, Western Australia*, Philip Burrill, *Department of Employment, Economic Development and Innovation, Queensland Primary Industries and Fisheries, Hermitage Research Station*, Jim Moran, *Department of Primary Industries*, Sharyn Taylor, Jo Slattery and Stephen Dibley, *Plant Health Australia*

The national 'Grains On-farm Biosecurity Program' has aligned key awareness and education objectives to current grains industry extension programs, to deliver farm biosecurity messages seamlessly. A critical element to the success of these strategic alliances is "value adding" to existing programs

content, with biosecurity information integrated in the right context with other farming-system information, as opposed to a stand – alone issue.

Alliances with national programs such as the Grains Research and Development Corporation (GRDC) National Invertebrate Pest Initiative (NIPI) and Partners in Grain has enabled a large network of agronomists, farmers and other industry providers to become skilled in identifying and monitoring both endemic and exotic pest and disease threats to the grains industry. NIPI delivery avenues include invertebrate identification workshops and interactive newsletters such as PestFax/PestFacts services, which encourages reporting of seasonal pests and diseases to assist industry in on-farm surveillance. Trial contractors working in the GRDC National Variety Testing trials also assist with on-farm surveillance of exotic pest threats, and serve to act as role models to growers.

State-based initiatives such as GrainGuard (Western Australia) and CropSafe (Victoria) provide excellent communication platforms for industry personnel to identify and discuss farm biosecurity issues and strategies required to minimise any threats to the grains industry

These dynamic and interactive partnerships in grains extension programs provide benefits to the industry and play an important role in the initial adoption phases; facilitates interactive flow of information and discussion on the evolving options; improves education and assists biosecurity awareness and preparedness. Disseminating and specially tailoring grains biosecurity education into existing programs is also extremely valuable in providing dynamic levels of participation and enhancement of learning experiences which can be evaluated and built upon in the future. More importantly, growers receive a more targeted and prescriptive package which can be effectively applied on-farm.

Biography: Judy Bellati is the Grains Biosecurity Officer for South Australia. Judy is a passionate entomologist with an extensive range of skills and experience, and expertise in grains entomology and extension. Judy previously worked on the National Invertebrate Pest Initiative (NIPI) funded by the Grains Research and Development Corporation (GRDC) where she coordinated South Australian communication and extension activities including the interactive newsletter PestFacts (SA and western Victoria edition), diagnostic services, development and delivery of invertebrate identification workshops and presentations to the grains industry. Judy also coordinated and co-authored the Crop Insects Ute Guide for the Southern Region and a training resource manual.

Lisa Sherriff is the National Grains Industry Biosecurity Co-ordinator, Western Australia. Lisa has had a wide range of experience across Australia in both Grains and Horticultural crops. Lisa began her career in Agriculture as a consulting agronomist prior to joining the Department of Agriculture & Food WA to take on projects centered around farming systems analysis, climate risk management and grains industry biosecurity.

Grain knowledge networks and risk management for phosphine resistance in stored grain insects

Anna Carr, Michelle Young, Sarah White and Treena Benedictos, *Social Science and Policy, Bureau of Rural Sciences, DAFF*

Phosphine is a fumigant used for insect pest management in the Australian grains industry. Its continued effectiveness is essential to the sustainability of grain hygiene and market access for Australian grains. In the past 10-15 years, resistance to phosphine in target insect pests has increased in both frequency and strength such that it may now threaten effective control.

This paper explores the attitudes, knowledge and practices of stakeholders in the grains industry in relation to phosphine resistance management (PRM). There is a particular focus on the knowledge and practices of grain growers in relation to phosphine fumigation informed by local case studies with growers in NSW, QLD, VIC, SA and WA. The available options for improving PRM are explored including: identification of critical paths for exchanging knowledge about managing insect resistance within the grains industry; and the development and standardisation of industry standards, protocols and regulation.

Qualitative research methods based on stakeholder interviews were analysed using NVivo software. Key findings include:

- the need to increase awareness among growers of both the incidence of resistance and the implications of resistance
- the need to ensure that pesticide labels meet the needs of fumigators
- the need for effective fumigation on-farm, including developing industry standards for sealed silos and testing silos on-farm
- the role of agribusiness consultants and extension agents in the exchange of information for PRM
- the need for investment in grain storage infrastructure both on-farm and in bulk storage that is both gas-tight and has capacity for cooling and aeration.

It is suggested that future planning for PRM in Australia needs to facilitate change in the storage and delivery of grain, particularly in terms of how long grain is stored in silos or other facilities which may or may not be adequately sealed.

Biography: Anna's interdisciplinary background in communication studies, economics and environmental sociology provides a unique basis to explore the relationship between public science and society. As a social scientist within a biophysical science context with farming experience, she is interested in scientists' understandings of publics and processes of public engagement and dialogue about risk, trust and expertise. She has worked with horticulturists, irrigators, foresters and graziers across Australia. Currently, she works on social dimensions of biosecurity and fisheries with the Bureau of Rural Sciences, in the Australian Government Department of Agriculture Fisheries & Forestry.

RabbitScan – engaging community knowledge

Graeme Martin, *Spatial Vision*

How do you muster 3,000 people across Australia to monitor the impact of rabbits?

RabbitScan is a national community, schools and science challenge to raise awareness of the threat posed by rabbits. New data, especially the extent of rabbits across Australia is critical to create an evidence base to understand their current impact on the landscape and to plan control measures. RabbitScan is a unique national project aimed at engaging people in 'scanning' their landscape (school, farm, parkland, roadside reserves, ovals etc) for signs of rabbits and to load information and images into a national online spatial database.

The RabbitScan initiative was conceived by the Invasive Animals Cooperative Research Centre and Rabbit Management Advisory Group. Spatial Vision established an interactive web mapping site for people to record their scans. The web mapping application was designed to capture consistent survey results into a database to enable the production of a national map to be used by science and regional NRM organisations.

Given the potential speed of environmental changes associated with climate change, engaging community knowledge may become an important means to gather timely information to support critical decisions on biosecurity.

This paper outlines the rationale for RabbitScan; a review outcomes of the map-based survey; lessons learnt from conducting a national community engagement approach to this issue and other examples of where this approach may be applied.

Biography: Graeme manages Spatial Vision's Consulting Division. Graeme has 20 years experience in the design and implementation of information systems and provision of advice to make effective use of spatial technology.

Graeme holds a Masters in Environmental Science from Monash University.

Graeme's 1992 Master's thesis explored the role that GIS could play in facilitating engagement between government and Landcare groups in land management. Graeme has undertaken international development work in Vietnam and Papua New Guinea. Graeme also undertakes significant community work. The Darebin Parklands Association (with Graeme as president) won a United Nations World Environment Day award and NAB National Volunteers Award.

Capacities needed to develop robust biosecurity organisations and policy

Peter Black, Belinda Wright, Jill Mortier and Peter Beers, *Australian Government Department of Agriculture, Fisheries and Forestry*

Many organisations dealing with biosecurity issues are grappling with the challenge of improving their capacity to undertake more robust, broad-ranging analysis to better inform biosecurity policy. Biosecurity organisations also need to design built-in coping strategies that increase resilience to operate effectively within this complex and rapidly evolving policy domain. One of the common pitfalls is for organisations to concentrate on improving their strategic planning capacity at the expense of developing a broader anticipatory action learning approach across the organisation.

At a minimum, organisations need to focus on assessing the implications of present actions and decisions (consequence assessment), identifying and avoiding problems before they occur (early warning and guidance), and considering the present implications of possible future events (proactive strategy formulation).

How can this be achieved? Firstly, it is critical to avoid consistently projecting the past into the future. Secondly, supporting and developing an innovation culture—which does take time—is essential. The ultimate challenge is to create a questioning, learning organisation where longer term thinking and an appreciation of complex system dynamics is the norm. Such organisations are flexible, so even if its members get the future 'wrong', the organisation is well prepared to adapt to the future as it unfolds. This paper reviews a number of approaches taken by institutions in the United Kingdom, the United States of America, Finland and the Netherlands and assesses their success in creating resilient organisations able to deal with the unexpected.

Biography: Dr Black currently works in the International Programs and Disease Intelligence section of the Office of the Chief Veterinary Officer within the Australian Government Department of Agriculture, Fisheries and Forestry. He has worked as a field veterinarian in Queensland and held policy development roles at the state and national level. He has postgraduate degrees in veterinary epidemiology and strategic foresight. Dr Black is actively involved in the Australian Biosecurity Cooperative Research Centre and co-supervises PhD students working in areas ranging from foot-and-mouth disease surveillance and control, to the investigation of patterns of infectious disease emergence in the Australasian region.

Biosecurity – the front line

Chris Hawkins, *Department of Agriculture and Food Western Australia* and Sarah Palmer, *Murdoch University*

Biosecurity has two key elements: quarantine, which is usually the responsibility of the state or country involved, and surveillance, which needs to be sufficiently sensitive to provide an early warning system should an adverse event occur.

The front line of any surveillance system for livestock is the producer, whose decision to report or advise of such an event is critical for implementation of effective action. However, surveillance information from producers is declining. Reasons for the decline in the provision of information by producers are complex. Producer perceptions of biosecurity and their role as front line agents are discussed, along with suggested strategies for enhancing producer response.

Biography: Chris joined the Department of Agriculture and Food in 1990, and has been based in rural Western Australia since then. His work with the agency involves evaluating animal health and production in the Northern Agricultural Region, including disease surveillance; evaluating the effectiveness of the Department's animal health programmes; conducting risk analyses and providing advice to management on biosecurity and animal health policy; and industry advice and consultation. Research activities cover the areas of biosecurity, enhanced surveillance, and disease control, in WA as well as overseas and includes the supervision of postgraduate students through Murdoch University, in his capacity of Adjunct Professor.

New technologies for disease surveillance

Angus Cameron, *AusVet Animal Health Service*

Technological advances over the last decade have provided a range of new opportunities for improved animal disease surveillance. This presentation reviews a number of these technologies and discusses their potential application. Some are already well established in existing surveillance systems, some are the subject of current research and some are simply ideas waiting to be developed.

The internet is an important driver for new surveillance tools simplifying rapid disease reporting and access to centralised databases. The breadth of coverage of current events through official news organisations as well as informal reporting (Blogs, Twitter etc) has provided a rich source of disease information, and systems have been developed to mine this data to extract key information (for example, Google Flu Trends, WHO and USDA systems).

Communication technologies have had a big impact on data collection systems. These range from the very simple, such as coded SMS reporting systems used in many countries, to the more complex (digital pens that capture images of completed report forms, transfer them by mobile phone to a central computer which analyses the content with optical character recognition and inserts the data into a database, all in real time).

Further examples include intelligent systems to improve remote non-veterinary reporting of signs of disease, the increasingly widespread use of databases for the routine reporting of production data which may be used for surveillance purposes, and innovative satellite and terrestrially based remote sensing systems to analyse habitat, vector distribution and animal movement patterns. Improved diagnostic technologies have had widespread impacts, including new opportunities for wildlife surveillance using biting insects as flying syringes.

There are many exciting new possibilities in disease surveillance, but care will be required to match the right tool to the specific task at hand.

Biography: Angus Cameron is a veterinary epidemiologist with special interest in disease surveillance, freedom from disease, information systems and geographic information systems (GIS). He is director of AusVet Animal Health Services, a private epidemiology company. Angus shares his time between France and Australia, and is regularly involved in projects in Australia, Asia, Europe, North America and Africa

Point of truth calibration: putting science into scoring systems

Simon Barry and Xun Guo Lin, *CSIRO Mathematical and Information Sciences*

Scoring systems are commonly employed in risk analysis as a way of integrating information about a range of attributes into a single risk score suitable for decision making. Typical applications include risk assessment for importation or targeting algorithms for inspection. A popular way of defining these systems is to use experts. The experts construct weighting schemes and aggregation methods based on their beliefs. This approach is often criticised as being arbitrary as there is no transparent basis for the selections or calibration to empirical data. This can undermine the effectiveness of the techniques in decision making..

This talk proposes an alternative approach which overcomes these difficulties. The method we propose is called POTCal (i.e. the Point of Truth Calibration). It uses expert judgements from constructed risk scenarios rather than providing individual scores of risk attributes. We argue that it provides an improved form of expert elicitation for many complex risk assessment problems. The proposed method will `automatically' calibrate weightings (scores) of risk attributes from the overall risks given by experts using well developed statistical regression techniques. Several examples from real biosecurity applications are presented to demonstrate the approach.

Biography: Simon Barry has a degree in Science and a PhD in Biostatistics from the Australian National University. After lecturing at ANU he joined the Bureau of Rural sciences in the Department of Agriculture, Fisheries and Forestry where he built the Risk and Modelling group. In the department he was involved in a range of biosecurity issues such as developing the risk based decision support frameworks for the national system for managing marine pests, deveoping scoring systems for risk

assessment of vertebrate animals, import risk assessment for high profile agricultural commodities, the development of efficient monitoring programs and the devopment of approaches to species distribution modelling and cost sharing. Simon is currently program leader for the Environmental Informatics program in CSIRO mathematics, informatics and statistics. This program works on a wide range of environmental monitoring and risk assessment problems.

Harnessing expert knowledge for biosecurity

Samantha Low-Choy, *Cooperative Research Centre National Plant Biosecurity and School of Mathematical Sciences, Queensland University of Technology* and Kerrie Mengersen, *School of Mathematical Sciences, Queensland University of Technology*

In Biosecurity contexts, expert knowledge is a valuable resource. Indeed expert opinions can provide the basis for informing decision-making and resource allocation, via such instruments as risk assessments and surveillance design. Experts may provide preliminary estimates where empirical data is limited. Examples from our experience include assessing import hazards and risks due to entry, establishment or spread; and estimating detectability using different trapping or survey methods. Experts also add considerable value to such information, by applying scientific thinking to evaluate, then integrate information in a balanced way, using diverse sources that are often of varying type and quality. In this paper we illustrate different ways of harnessing expert knowledge in biosecurity contexts by examining several case studies, both from our own experience and from the literature.

A diverse range of modelling methods for incorporating expert opinions has been employed in biosecurity or allied fields. Bayesian Networks and Multiple Criterion Decision Analysis are both popular methods that exemplify a conceptual approach, where experts specify both the model structure and the model inputs. Alternatively process models require input parameters which often require expert assessment or specification. Bayesian statistics (a more general modelling framework than Bayesian Networks) provides an empirical approach that reflects a cycle of learning: expert know ledge is captured and expressed as a "prior" model, then updated with empirical data. These prior models may reflect opinions from an individual expert, or combined across multiple experts, or a meta-analysis of the literature. Regardless of the modelling approach, expert elicitation undertaken using a statistically robust protocol can help ensure repeatable and transparent elicitation of knowledge, and draws on multidisciplinary efforts across statistics, risk assessment, psychology and philosophy. We use case studies to illustrate how this more structured approach to elicitation can harness expert knowledge in a range of biosecurity contexts.

Biography: Samantha Low-Choy is a PhD in Spatial Statistics (Queensland University of Technology); 7 years as lead environmetrician in State Government; 5 years' post doctoral research in Bayesian statistics. Previous experience includes teaching and statistical consulting in various fields. Currently Senior Research Fellow in the Cooperative Research Centre for National Plant Biosecurity, Australia. Expertise and current interests in tailoring Bayesian statistics to design and modelling in biosecurity, environment and ecology, esp. habitat, detectability, species invasion, ecoregions, and ecological or health impacts. Statistical research interests also include: statistical methods and software for eliciting and encoding expert knowledge; and calibrating and combining multiple expert opinions.

Evidence for absence from absence of evidence – quantifying the value of general surveillance

Tony Martin, *Department of Agriculture and Food Western Australia*, Nichole Hammond, *Department of Agriculture and Food Western Australia, School of Veterinary & Biomedical Sciences, Murdoch University, Western Australia and Cooperative Research Centre for National Plant Biosecurity*, Greg Hood, *Australian government Department of Agriculture Fisheries and Forestry*, Rochelle Watkins, *Australian Biosecurity Cooperative Research Centre for Emerging Infectious Diseases* and Evan Sergeant, Jenny Hutchison, Angus Cameron, *AusVet Animal Health Services*

In order to claim freedom from a disease of animals or plants, or an unwanted pest species, evidence is required. In general it is expected that quantitative evidence will be derived from the negative

outcomes of targetted, active surveillance designed to detect the pest should it be present. Such surveys may be representative of the whole "population" or area at risk, or may target high-risk sections of the population or area. Almost always, the fact that the pest or disease has not been noticed by anyone over a period of time, quite apart from any active surveillance activities, is acknowledged only as a qualitative observation, consistent with freedom. We fail to ascribe quantitative value to the general surveillance processes which are responsible for almost all detections of unwanted pests and diseases. This failure ignores some of the best evidence there is for freedom, fails to value the resources invested in the diagnostic processes, and leads to unnecessarily large demands being placed on active surveillance.

Quantitative evidence for freedom may be derived from multiple, varied surveillance activities, and combined into a single estimate of the sensitivity of the surveillance system, and of certainty or confidence in the population or area being free from the pest or disease. General surveillance is a part of the surveillance system, and its sensitivity may be estimated from a probabilistic model which includes all the steps necessary for infection in the population to be detected by the surveillance process. Such models are conceptually simple, and readily described, although estimation of some parameters may rely on expert opinion. In this paper we outline quantitative modelling of the sensitivity of general surveillance activities, using examples from animal health, plant health, human health and invasive species, and demonstrate how the results may be used in support of claims of freedom.

Biography: Tony Martin is a veterinary epidemiologist with the Western Australian Department of Agriculture and Food. He has worked in mixed veterinary practices, a veterinary school and an international organisation, as well as government. Together with his co-authors he recently co-developed a quantitative framework for incorporating multiple, varied sources of surveillance information into evidence for pest and disease freedom. This research was supported by the Australian Biosecurity CRC, for whom he has also led other projects in the surveillance field.

How to deal with evidence uncertainty in biosecurity decision-making?

Kim E. Lowell, Michael Hurley, *Department of Primary Industries – Victoria and Cooperative Research Centre for National Plant Biosecurity* and Cindy Hauser, *Australian Centre of Excellence for Risk Analysis, University of Melbourne*

It is acknowledged that a considerable amount of uncertainty is inherent in the scientific evidence used to plan for biosecurity risks and incursions. An often unspoken corollary to this is that if one had an estimate of this uncertainty, one would be able to make better decisions. Yet consideration of uncertainty in a decision-making context adds considerable complexity to the process. This article will explore the issue of including uncertainty in the decision-making process including a discussion of alternative methods of using the uncertainty. A simplistic biosecurity example is employed that is based on scientific evidence that can be well-described mathematically. Alternative decision rules are employed and implications for expenditure and biosecurity protection determined. A major conclusion of the work is that including uncertainty in a biosecurity decision requires the decision-maker to be much better informed about the question they are asking and their own risk tolerance.

Biography: Kim Lowell has a dual position as a Principal Scientist with the Department of Primary Industries and a Professorial Fellow in the CRC for Spatial Information through the University of Melbourne. He has worked in the domain of data quality and uncertainty analysis for over 20 years. He currently leads the Victoria node of a national biosecurity project co-funded by the Cooperative Research Centre for National Plant Biosecurity, Plant Health Australia, Horticulture Australia Limited, and the Rural Industries Research and Development Corporation.

Preferences and priorities in risk mitigation across multiple values

Terry Walshe, Tracy Rout, *Australian Centre of Excellence for Risk Analysis,* Mike Cole and Neil Grant, *Department of Agriculture Fisheries and Forestry*

Pests and diseases impact agricultural production, ecological health and human health. Prioritising actions aimed at mitigating risks involves value judgments on the relative importance of market and

non-market impacts. Deliberate methods to account for value judgments include elicitation of the preferences of decision-makers and stakeholders in multi-criteria decision analysis, or contingent valuation techniques in benefit-cost analysis. These methods can be cognitively demanding, time-consuming and costly. Judgments may be clouded by uncertainty in technical assessment of the magnitude of impacts. Difficulties with inconsistent or incoherent preferences are commonly encountered. This paper outlines an alternative approach to combining value judgments and technical assessments using rough sets. We show how rough sets can accommodate uncertainty and intransitive preferences, and how they can be used to derive decision rules to inform priorities for management action.

Biography: Terry Walshe is Deputy Director of the Australian Centre of Excellence for Risk Analysis. He teaches environmental risk assessment at the University of Melbourne. His research deals with the intersection of technical tools and social judgments. He has contributed to risk analysis in forest management, conservation planning, fisheries management, alpine ecology, river restoration, fire management, irrigation, salinity and biosecurity.

Finding the hole in the dyke: how to stop the spread of pests using aquatic weeds in Australia as a case study

Byron Pakula and Stuart Raetz, *Roberts Evaluation*

This paper will demonstrate the use of multi-disciplined approaches to pest management and evaluation, such as the combined use of economics, network analysis, communications, and theory of social capital. An aquatic weed case study demonstrates the use of evaluation results and improved knowledge as a tool for evidenced-based stakeholder engagement to be used in biosecurity program development and implementation.

Aquatic weeds in Australia are introduced through the aquatic plant industry by formal and informal actors. A stakeholder network analysis was conducted to highlight the flow and strength of information and influence amongst stakeholders in the supply chain of aquatic plants. Data for this analysis was collected using semi-structured interviews, based on an initial scoping study to identify stakeholders of interest. The analysis was supported by an economic analysis to understand supply, demand and competitive forces that shape the aquatic plant industry and supply chain.

A visual representation of the network of stakeholders was created to assist in understanding the structure of the industry. The representation illustrated the industry is separated into industry sectors including the garden and nursery industry, the aquarium and pet shop industry, and informal traders. Information hubs and conduits were identified including water garden industry bodies, plant industry bodies, and key wholesalers including a single large aquarium plant grower/wholesaler. These providers were considered ideal nodes for disseminating information relating to plant identification and legislative requirements.

The research was commissioned by the Victorian Department of Primary Industries and has been subsequently used to better target stakeholders to prevent the spread of aquatic weeds through the aquatic plant industry. By using an economic framework in conjunction with a stakeholder network analysis approach, a better understanding of the role stakeholders and their position within a complex system was produced. This information has since formed the basis for an evidence-based engagement strategy for implementing pest related policies and programmes.

Biography: Byron Pakula is a senior consultant at Roberts Evaluation, specializing in agriculture and natural resource evaluations. Byron is an economist that has worked on agricultural related policies and evaluations in Australia and internationally, including Victorian Department of Primary Industries, Bangladesh think tanks, Australian Red Cross in Sri Lanka. Recently he has undertaken reviews of several biosecurity and pest related strategies, plans and projects, with an interest in understanding the social / wicked problems and its inter-relationship with economics influences and impacts.

Stuart Raetz is a consultant at Roberts Evaluation, with a background in sociology. He has a strong understanding of qualitative research methodologies and has experience in undertaking stakeholder analysis and social impact assessment, as well as monitoring and evaluating community engagement and development programs. Stuart has undertaken several biosecurity and pest related reviews focusing on community engagement, communication and understand interactions in pest monitoring and management on private and public land.

New methods of providing statistical confidence in zero detections for surveillance programs – a case study in the eradication of Yellow Crazy Ants

Bernie Dominiak, *New South Wales Department of Primary Industries*

After an incursion of a pest, traditionally a period of zero detections is used for a nominal period as a basis of declaring freedom from the pest. However these zero detections, often for two years, do not provide any statistical confidence that the pest is genuinely absent or eradicated. Using two novel approaches after the eradication of Yellow Crazy Ants from northern NSW, there are new methods of providing a statistical level of confidence that the pest is absent. This is based on the probability that the pest is present but not detected. Incursion pressure can be added into the model. Also component sensitivity can be estimated, and hence frequency of certain surveillance methods might be chosen to accelerate the recognition of freedom based on statistical confidence. These new methods will also identify what level of inspection is required to maintain area freedom under different incursion pressures. These new analyses will overcome the present arbitrary period of absence of detection currently used, and remove the temptation to increase this period as the only way of increasing confidence that the pest is not present.

Biography: Dr Dominiak coordinates plant based surveillance systems in NSW including fruit flies, fire ants, small hive beetle, sycamore lace bug and other endemic and exotic plant pests.

Enhancing New Zealand's animal identification and tracing systems: experiences developing a system for tracking and tracing cattle and deer

Christopher W Houston, *MAF Biosecurity New Zealand*, I Govey, C King, K Creswell, A Pearse, D Heinz, B O'Brian, R Barnes, L Burton, D Birnie and S Keenan

To improve capability in responding effectively to a biosecurity or food safety emergency and to ensure on-going consumer confidence in New Zealand's livestock produce, Government and industry organisations have come together to develop a new integrated system for the identification and tracing of livestock - the National Animal Identification and Tracing (NAIT) project. The scope of the proposed scheme is initially limited to cattle and deer. Regulations requiring compliance with new procedures to support NAIT are expected to be in place by 2011. This paper describes progress in developing the NAIT system together with discussion of some of the associated issues and challenges faced by the project to date or on the horizon.

Biography: Chris Houston has worked as a Senior Adviser for MAF Biosecurity New Zealand since 2007 in animal disease surveillance and incursion response. Prior to joining MAFBNZ, Chris worked for the UK Department for Environment, Food and Rural Affairs (defra) in Veterinary Surveillance and as part of the National Emergencies Epidemiology Group (NEEG).

Chris has a PhD in bacterial genetics and an MSc in Veterinary Epidemiology from the Royal Veterinary College.

Surveillance and capacity building for exotic plant pathogens in the Australian Cotton Industry

Chris Anderson, Alison Seyb, *NSW Department of Industry and Investment and Cotton Catchment Communities CRC*, Linda Smith, Linda Scheikowski, *Queensland Primary Industries and Fisheries and Cotton Catchment Communities CRC*, Stephen Allen, *Cotton Seed Distributors and Cotton Catchment Communities CRC,* David Nehl, *NSW Department of Industry and Investment*, Sharyn Taylor, *Plant Health Australia* and Greg Kauter, *Cotton Australia*

The Cotton Industry Biosecurity Plan (IBP) was first released in 2006 as part of a national effort to safeguard the industry against incursions of exotic pests. Of the twelve high priority plant pests (HPPs), the six plant pathogens are 1) exotic races of *Fusarium oxysporum* f.sp. *vasinfectum*, 2) Cotton Leaf Curl virus, 3) hyper virulent strains of bacterial blight, 4) *Phymatotrichopsis omnivora,* 5) exotic races of *Verticillium dahliae* and 6) cotton blue disease (Luteovirus). National, State and Farm surveillance

have been flagged as key components of an industry wide surveillance program for these exotic pathogens. Bi-annual surveillance of endemic cotton diseases has been conducted in NSW since 1983 and in QLD since 2002 in a joint effort by the industry and state governments. Surveys are conducted in all major cotton growing regions and can take into account up to 100,000 individual plants each season. Plant pathologists conducting the surveys are familiar with the HPPs and are now recording absence data for each exotic pathogen. This data is entered into NPSRT database. In addition to national and state surveillance efforts, Cotton Australia has recently introduced a Biosecurity module to its Best Management Practice certification. Growers are encouraged to adopt farm hygiene practices, familiarise themselves with the EPPs and conduct some level of on-farm surveillance. Furthermore, Plant Health Australia has provided training for consultants and growers to raise awareness of Biosecurity issues in the industry and further training sessions are anticipated. Extension material including a Farm Biosecurity Manual is likely to be available to growers in the near future, and fact sheets for each EPP are currently being revised as part of the implementation of the IBP. The industry has also sought to ensure that several of its plant pathologists have first hand experience in field and laboratory based identification of EPPs.

Biography: Chris Anderson is a graduate of the University of Sydney who has worked as a plant pathologist to the cotton industry for five years. Chris is a member of the Cotton Industry Biosecurity Group and heads up the cotton disease surveys in New South Wales conducting surveillance for endemic and exotic plant pathogens. Chris is currently completing his PhD through the University of Sydney on the phylogenetics of *Rhizoctonia* associated with cotton in Australia and overseas. Chris has a keen research interest in better preparing the Australian cotton industry to detect and manage hyper-virulent strains of bacterial blight.

"Talking Toads": community perceptions of the threat, impact and management of cane toads in northern Australia

Anna Carr, Rachel Clarke, Jeanine Baker, Bo Raphael and Sarah White, *Bureau of Rural Science, DAFF*

The cane toad *Bufo marinus* was introduced to Gordonvale, Queensland in 1935. Since then the cane toad has spread throughout Queensland, parts of New South Wales, the Northern Territory, and has recently reached the Western Australian border. Whilst there has been some research around the ecological impacts of cane toads on Australian ecosystems, there has been little research on the impact of the cane toad on society and in communities.

This qualitative research investigated community perceptions of threats, impacts and management of cane toads across northern Australia. The primary objectives of the project were to:

1. identify key themes in community motivations and perception of the threat, impact and management of cane toads
2. describe temporal and geographic differences in community perception of the threat, impact and management of cane toads
3. identify key themes across demographic and cultural differences in northern communities.

Six case study sites were selected for the research: Cairns, Kowanyama, Ngukurr, Darwin, Kununurra and Broome, where the cane toad is yet to arrive. Semi-structured interviews and focus groups were held with approximately 300 people. Questions covered attitudes and observations about cane toads, perceived threats and impacts, management options and responsibilities.

Qualitative analysis software (NVivo) was used. Key findings included concern about local wildlife, threats to food sources, humane treatment of toads and a wide range of management suggestions. This paper suggests that future planning for management of invasive species in Australia needs to address community concerns and communication strategies as well as ecological impacts.

Biography: Anna's interdisciplinary background in communication studies, economics and environmental sociology provides a unique basis to explore the relationship between public science and society. As a social scientist within a biophysical science context with farming experience, she is interested in scientists' understandings of publics and processes of public engagement and dialogue about risk, trust and expertise. She has worked with horticulturists, irrigators, foresters and graziers

across Australia. Currently, she works on social dimensions of biosecurity and fisheries with the Bureau of Rural Sciences, in the Department of Agriculture Fisheries & Forestry

Biosecurity and taxonomic expertise

Penelope Greenslade, *Invasive Species Council*

The ability to accurately identify animals and plants is fundamental in order to properly protect a region against new, invasive species. If an intercepted organism has not been formally described and has an acceptable name, it is impossible to determine whether it is already present in the region being considered or not. Intercepted invasive species may already have colonised a new region, be detected at pre-or post-border inspections or be potential invaders because they are associated with a commodity to be imported. Moreover, without a name, no biological information can be associated with the organism so it cannot be assessed for probability of entry, establishment and spread. Estimations of the risk of an undescribed organism entering, establishing and spreading in any region will therefore be problematic.

Unfortunately, in Australia, taxonomic expertise has been falling in recent years, possibly ever since the early 1990s. Several surveys have documented the decline. The reasons remain obscure but appear to be due to a combination of factors. Firstly, there is a common perception among students and others that taxonomy, or, more correctly systematics, is lacking in appeal and challenge compared to topics such as ecological studies on charismatic Australian vertebrates. The discipline has been considered to be similar to stamp collecting. Another reason may be that studying small organisms requires meticulous techniques of preparation which is an ability which has not been highly valued in education in recent years. Finally and perhaps most importantly, the reduction of paid positions in museums and the decline in courses in systematics at many universities must also play a part.

Examples will be given of incidents where lack of relevant taxonomic expertise resulted in breaches of biosecurity or delay in control of an exotic invader.

Biography: Penelope Greenslade is a taxonomist of soil animals and is particularly interested in invasive species, their biological characteristics and origins. She has published on prioritising threats from invasive species and maps of their distributions. She worked for some years in Biosecurity Australia, a Commonwealth body, writing import risk assessments.

Biosecurity: Wicked Problems, Wicked Solutions

Byron Pakula, *Roberts Evaluation*

Biosecurity is not a complex problem, it is a wicked problem.

Wicked problems, such as biosecurity and invasive plant and animal management, are characterised by multi-faceted issues. In particular biosecurity is a unique problem involving numerous stakeholders across a range of jurisdictions and regional boundaries, does not conveniently sit within the responsibility of any one organisation, and is associated with competing objectives. The wicked solutions require changing behavior and practices of agencies, organisations and land managers. However, there is not one optimal solution, rather a mix of approaches.

The approaches that can be used are authoritative, competitive or collaborative. This paper argues that the most effective and efficient approach to manage biosecurity is through a collaborative approach. This requires leveraging the power of collaborative networks – and creating them where they do not exist – in order to bridge the divide between biosecurity research, policy and implementation.

This paper views biosecurity through the wicked problem framework to help identify knowledge practices and systems to improve invasive plant and animal management outcomes. Wicked problem theory promotes harmonisation and sharing of knowledge, strategies shaped around cross jurisdictional and institutional coordination, and national and internationally integrated approaches. This is most important for pest management planning and targeting of established pests.

As Australia is at the forefront of invasive plant and animal management, it is essential we learn from other wicked problems. The well developed risk analysis frameworks, knowledge sharing and collaborative approaches of public health and epidemiology also provide useful lessons. The research for this paper was commissioned by the Victorian Department of Primary Industries to assist the development of the Victorian Biosecurity Framework.

Biography: Byron Pakula is a senior consultant at Roberts Evaluation, specializing in agriculture and natural resource evaluations. Byron is an economist that has worked on agricultural related policies and evaluations in Australia and internationally, including Victorian Department of Primary Industries, Bangladesh think tanks, Australian Red Cross in Sri Lanka. Recently he has undertaken reviews of several biosecurity and pest related strategies, plans and projects, with an interest in understanding the social / wicked problems and its inter-relationship with economics influences and impacts.

Modelling the establishment and spread of Emergency Plant Pests (EPPs) in Australia: simulate or suffer

Juan Jose Garcia Adeva, *Cooperative Research Centre for National Plant Biosecurity and School of Computer Science and Software Engineering, The University of Western Australia*, M.J. De Sousa-Majer, J.H Botha, C.D Hanbury, D.C Hardie, *Department of Agriculture and Food and Cooperative Research Centre for National Plant Biosecurity* and M Reynolds, *Cooperative Research Centre for National Plant Biosecurity and School of Computer Science and Software Engineering, The University of Western Australia*

EPPs invasion can have large economic impacts by provoking losses in agriculture, habitat degradation, and disruption in public areas. EPPs are widely recognised as a major component in global change. With this vision in mind, we are developing a simulation platform to model the population dynamics of EPPs for Australia in case they were ever to be detected here. The model takes into consideration the prediction of growth, dispersal over a spatial landscape, and tracking of generational development over time. We are focussing on four distinct EPP types: Fruit flies (*Bactrocera* spp.), Asian gyspy moth (*Lymantria dispar*), Khapra beetle (*Trogoderma granarium*), and the disease Fire blight (*Erwinia amylovora*). Their host availability, quality, and suitability are included into the model in order to estimate how the insect population is affected in terms of fecundity (Allee effect), mortality, and developmental rate. Similarly, the effects of climatic variables such as temperature, wind, and rainfall are incorporated into the simulation model. We use a climate/habitat match to target spatial regions where there is an interface between urban, rural, urban–rural peripheral, and farm and forest landscapes to estimate the rate of spread of the pest. We aim to integrate the spatial structure of the landscape to the specific biology of each EPP in order to predict the degree of invasion success and pattern of spread i.e. considering how the insect moves within their habitat and their dispersal distance. The Cooperative Research Centre for National Plant Biosecurity recognises the importance of understanding and predicting the spread of EPPs for the development of detection, eradication, and containment or control strategies.

Biography: Juan J. G Adeva earned a BEng in Computer Engineering from the University of the Basque Country in Spain, a MSc in Computer Science and Mathematics from the University of Essex in the UK, and a PhD in Engineering from the University of Sydney. He has worked for over 12 years in R&D with organisations, companies, and universities in Spain, the UK, the US, and Australia. He currently works as a research fellow at the School of Computer Science and Software Engineering of the University of Western Australia. His position is funded by the CRC Plant Biosecurity within the project "surveillance platform technology for predicting spread of EPPs".

AUSFLU simulation modelling environment for pandemic influenza

Sam Beckett, *Broadleaf Capital International Pty Ltd*, Graeme Garner, *Australian Government Department of Agriculture, Fisheries and Forestry*, Pip Pattison, Garry Robins, Rochelle Watkins, *James Curtin University of Technology*, Helen Cameron, *Australian Government Department of Health and Ageing* and Keith Eastwood, *Hunter New England Population Health, NSW Health*

In this paper we introduce AUSFLU, a flexible and powerful stochastic simulating modelling environment for pandemic influenza. AUSFLU includes both simple and complex spatial and non-spatial state-transition models. It has a user-friendly interface that enables public health policy researchers to examine the epidemiology of pandemic influenza and its control. AUSFLU has been configured to mirror a closely as possible the interventions the Australian Health Management Plan for Pandemic Influenza (2008). These include a range of measures for social distancing, as well as strategies for antiviral treatment and pre/post-exposure prophylaxis, and the use of candidate and customised vaccination.

AUSFLU has been developed using Australian Census (2006) data, as well as a series of surveys carried out in the urban centre of Tamworth in northwest NSW. This has provided a data structure and contact parameters that can be considered typical of a regional Australian town. AUSFLU also includes a wizard that enables users to import data for any other town up to a size of 200,000 individuals.

AUSFLU has been written in MapBasic and takes advantage of the spatial analysis and mapping capabilities of MapInfo Professional. It is an interactive Windows-based modelling environment and requires no programming nor specialist technical skills to operate, and no system requirements other than those require for Windows XP or Vista. AUSFLU is a collaborative project funded by the Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease.

Biography: Sam Beckett is a specialist risk analyst and epidemiologist who has worked in Australia and overseas as a consultant, and as a senior manager in the Australian Government.

His expertise and interests include:

- Climate change risk management for the private and public sector
- Animal and plant biosecurity risk management
- Spatial analysis and simulation modelling
- Quantitative epidemiology, and
- Animal and plant health information systems

Sam was for 6 years the Head Examiner for Epidemiology Membership to the Australian College of Veterinary Scientists, and is currently the designated Veterinary Epidemiologist for the National Animal Health Surveillance Strategy.

DNA barcoding, an emerging global standard for species identification, could revolutionise biosecurity diagnostics

Andrew Mitchell, *NSW Department of Primary Industries*

Our inability to identify the vast majority of the world's species is a major impediment to biosecurity. Rapid and accurate species identification, critical for detection of incursion of exotic species at borders or ports of entry and for surveillance and monitoring, is hampered by a lack of local knowledge or expertise, or because there are no diagnostic characteristics for the life stage encountered, e.g. immature insects. DNA barcodes provide a solution to many of these problems.

DNA barcodes are short DNA sequences used as tags to identify species and have been proposed as the backbone of a diagnostic system for all species of plants, animals and fungi. What distinguishes DNA barcoding from other diagnostic systems is its universality, expandability, strict data standards and most importantly its scale and speed of operation, borrowing techniques from genomics.

This system is rapidly emerging as a global standard for species identification, through the efforts of the Consortium for the Barcode of Life (CBOL), an international network comprising about 170 member organisations from more than 50 countries, and various international barcoding projects. Collectively these groups aim to create a publicly accessible online database of DNA barcode data and develop new instruments and processes that will make species identification cheaper, faster, and allow direct comparison of identifications among jurisdictions and against recognised standards.

The biosecurity community will benefit enormously from international cooperation to develop DNA barcodes for relevant organisms. However, it is essential that this developing standard is underpinned by sound taxonomy and adequate funding. Australia currently lags behind the rest of the developed world in these areas. Progress and prospects for DNA barcoding will be discussed.

Biography: Andrew is an insect systematist specialising in Lepidoptera. He was trained initially in wasp taxonomy at the University of Natal and subsequently received a PhD on the molecular systematics of

noctuid moths from the University of Maryland. He moved to Australia in 2004 as a BioFirst Awardee in order to establish a DNA barcoding research program in NSW. He is now Principal Research Scientist and Chair of the Steering Committee of the Australian Barcode of Life Network.

Next-gen molecular readout systems for biosecurity

Dr Bronwyn Battersby, *Nanomics BioSystems Pty Ltd*

The major aim of any successful biosecurity program is to avert entry of a pathogen or pest into a susceptible population of animals or plants. Early detection is crucial when precautionary measures fail. To this end, we are developing advanced molecular readout technologies which are suitable for discovery (BoB™) and diagnostic (OptoPlex™) applications.

Nanomics' BoB™ discovery platform enables libraries containing millions of peptides to be synthesized on polymer microbeads and easily tracked during an assay. The surface of each microbead is labeled with a unique combination of small fluorescent silica nanobeads, resulting in a readable optical barcode. This technology is particularly suited toward biomarker discovery, epitope mapping and viral protease profiling applications where large libraries are essential.

In collaboration with the AB-CRC, CRCNPB and QPI&F, Nanomics is focussing on developing new multiplexed tests for detection of pathogens which are highly significant biosecurity threats to public health, agriculture and the environment. These tests are based on Nanomics' OptoPlex™ bead technology. Differentiated from polymeric bead systems by their functionalised organosilica nature, tailored porosity and chemical robustness, the OptoPlex™ beads can be customised for a wide variety of multiplexed genomic, epigenetic and proteomic applications. Indeed, the ability to perform organic synthesis on the beads without disrupting their fluorescent code sets the OptoPlex system apart from all other bead systems. This advantage allows Nanomics to produce beads with a variety of unique polymer coatings which essentially eliminate non-specific protein binding. It also allows development of unique chemical methods for oriented attachment of antibodies, antibody fragments (scFv's), proteins, peptides and oligonucleotides for increased assay sensitivity and specificity. With the ability to run the OptoPlex assays on virtually any flow cytometer and potentially, future hand-held devices, the OptoPlex system is poised to become the next generation of biosensors for biosecurity applications.

Biography: Dr Battersby is a Project Director of Nanomics BioSystems Pty Ltd and a Senior Research Scientist at the Australian Institute for Bioengineering & Nanotechnology, The University of Queensland. Her work is focussed on development and commercialisation of biosensor technology for applications in biosecurity and cancer research.

Development of nationally endorsed diagnostic protocols for plant pests

Barbara Hall, *South Australian Research and Development Institute*

One of the main responsibilities of the Subcommittee on Plant Health Diagnostic Standards (SPHDS) is to facilitate the development and maintenance of national diagnostic standards to be used in the detection and identification of plant pests within Australia. Currently four reference standards have been developed to assist this process: 1) Glossary of Terms, 2) Technical Procedures for Development of Diagnostic Protocols and 3) Guidelines for the Approval Process of National Diagnostic Protocols and 4) Guidelines for Verification and Peer Review Reports . These reference standards have been adapted from the IPPC Procedural Manual (Section 10.2.3) and were developed to standardise and incorporate relevant information in diagnostic protocols for the identification of plant pests in Australia, and outline the process of assessment, by verification and peer review, for endorsement as National Diagnostic Standards. These endorsed Protocols are placed as a version controlled document on the SPHDS website to be used as part of a national response to emergency plant pest incidents and emergencies for specific pest species. There are more than 250 pests currently identified in Industry Biosecurity plans as being "high risk". SPHDS is responsible for prioritising the development of protocols for these pests for the Australian Government funded scholarships, provided annually to develop protocols in conjunction with providing offshore training for diagnosticians in the identification of the pests not present in Australia. There are also many protocols that have been developed in the last decade which need to be reviewed and updated, both to conform to the SPHDS format and ensure

they contain necessary relevant information and utilise appropriate technologies. Currently there are two endorsed protocols: NDP1 – Apple Brown Rot (*Monilinia fructigena*) and NDP2 - Plum Pox Virus. This paper illustrates the challenges of achieving endorsed National Diagnostic Protocols and in maintaining currency in a world with rapidly advancing information and technology.

Biography: Mrs Hall is the chair of the Diagnostic Standards Working Group of SPHDS, and is representing the members of the subcommittee

Guidelines for developing identification resources for plant protection and quarantine: accessibility, appropriateness, and circumscription

Dr Terrence Walters, *USDA APHIS PPQ CPHSI*

Developing and delivering identification aids, keys, and tools to support pest, disease, and weed identification requires an important investment in the planning and design phases of a resource to ensure they are valued and used by end-users. Agencies involved with plant protection and quarantine typically have personnel, off-shore, at ports, and domestically involved with survey, detection, trade, and identification that require rather diverse support resources (e.g., keys, image galleries, fact sheets, screening aids, etc.) based upon levels of expertise and identification responsibilities. Resource developers should take into consideration the following during the planning and design phases for a future resource: 1) how will the end-user access the resource, 2) what is the level of expertise (i.e., taxonomy, IT, etc.) of the end-users, 3) what type of resource is required for the responsibility (e.g., screening aids, keys, fact sheets, portal, etc.), 4) how and where will the resource will be used (i.e., field, laboratory, identification, verification, diagnostics, surveys, mobile devices, etc.), 5) what type of results are expected by the use of the resource, and 6) what is the scope (i.e., breadth, circumscription) of the resource.

Based on numerous years developing and delivering specialized identification resources to a diversity of teams within the United States Department of Agriculture (USDA), the Identification Technology Program will present guidelines for planning and designing valuable, user-friendly identification resources to support plant protection and quarantine.

Biography: Terrence Walters coordinates the USDA-APHIS-PPQ Identification Technology Program. The program delivers technologically-based resources that promote prompt accurate identification of pests, diseases, and weeds for safeguarding the United States and its trading partners' agriculture and natural resources today and for the future.

Categorisation of pests under the Emergency Plant Pest Response Deed (EPPRD)

Dr Sophie Petersen, *Plant Health Australia*

The Categorisation process for Emergency Plant Pests is integral to cost sharing under the Emergency Plant Pest Response Deed (EPPRD).

The membership of the Categorisation Group is specified in the EPPRD and is convened and Chaired by Plant Health Australia. The Categorisation Group also involves industry and government representatives as well as technical and economic experts.

The process of Categorisation aims to resolve the public versus private good of eradication of an Emergency Plant Pest (EPP) which, in turn, determines the cost shares to be borne by governments and industries affected by the EPP. There are four EPP Categories and associated response cost sharing splits between government (public) and industry (private) in the EPPRD. If an EPP is determined to have very high public benefit, it will be a Category 1 EPP and an eradication response would be 100% government funded. Category 2 EPPs are determined as having high public benefit with some private benefit and so eradication response costs are shared 80% government and 20% industry. Eradication of Category 3 EPPs have moderate public and private benefits and so are shared on a 50% government and 50% industry contribution and Category 4 EPPs have mainly private benefits to eradication and so are 20% government and 80% industry funded.

A nationally agreed questionnaire has been developed to assist in assessing public and private impacts of establishment of these pests and the respective benefits of eradication. Categorisation relies on information about Emergency Plant Pest biology, impact, control measures, and more. Much of this information is unknown and the behaviour of the Pest, if established in Australia, is also unknown. Information gaps are addressed through information sharing, information discovery and the commissioning of new research.

Biography: Dr Sophie Peterson was appointed Project Officer at PHA in August 2006. Sophie has an Honours degree in Horticultural Science and PhD specialising in Plant Pathology from the University of Sydney. Her PhD research was based on foliar fungi of New South Wales Waratah and was conducted in association with the Royal Botanic Gardens, Sydney. Sophie became Program Manager of the Emergency Plant Pest Response Deed Program in November 2008 and has responsibility for all aspects of EPPRD and national emergency response plan administration, PHA legal compliance, coordination of signatory agreement to EPPRD enhancements, and support for pest incursion responses.

Australia's EPP diagnostic database: the plant biosecurity toolbox

Amy E Carmichael, *School of Natural Resource Sciences, Queensland University of Technology and Cooperative Research Centre for National Plant Biosecurity*, G Kong, D Beasley and J Farrell, *Cooperative Research Centre for National Plant Biosecurity and Department of Employment, Economic Development and Innovation*

Rapid identification of emergency plant pest and pathogen incursions is essential to reduce the cost of eradication and impacts through rapid response. Diagnostic technology and data underpin our capacity for early identification and monitoring. Previously there was no single information resource, web-based or otherwise, to provide diagnostic information for targeted emergency plant pests (EPPs). Fast access to diagnostic information at the time of a suspected incursion is vital to biosecurity responsiveness.

This project has developed an easy-to-use, web- accessible national diagnostic database known as 'The Plant Biosecurity Toolbox' that helps users to quickly assess a suspected incursion. The Toolbox has a wide audience, providing information at a variety of levels – from general biology and risk analysis to detailed molecular tests. The Plant Biosecurity Toolbox contains a collection of diagnostic protocols for Emergency Plant Pests and provides users with images, taxonomic and biological information as well as identification instructions, diagnostic procedures and contact details for experts and accredited diagnostic laboratories. The toolbox is accessible via the PaDIL website (www.padil.gov.au/pbt), and provides access to other linked biosecurity diagnostic tools, such as the Remote Microscope Diagnostic Network and the Biosecurity Bank. In the next phase of the project, we are looking to develop portable pest modules for specific industries, which will be available for PDAs or as podcasts. The 'Plant Biosecurity Toolbox' will increase Australia's capacity and skills for plant biosecurity.

Biography: Amy Carmichael completed a Bachelor of Science (Entomology) at the University of Queensland, and Bachelor of Wildlife Illustration Honours at the University of Newcastle. Amy has worked on many projects involving interactive information resources and identification keys. Recent projects include *Dorsalis: An interactive identification tool to fruit flies of the Bactrocera dorsalis complex* and *TaroPest: An illustrated guide to pests and diseases of taro in the South Pacific.* Amy has been involved in the development of PaDIL (Pest and Diseases Image Library), is an active member of the Plant Biosecurity Toolbox project team and is currently developing PDA modules and podcasts of Toolbox information.

Strategies to increase plant biosecurity capacity in Australia

Kirsty L. Bayliss, *Cooperative Research Centre for National Plant Biosecurity*

When biosecurity scientists retire or leave the discipline for other reasons, gaps are created in the skill base and the capacity to respond to incursions is reduced. In Australia, this has been recognised as a significant issue for plant biosecurity organisations and their industry partners. The Cooperative Research Centre for National Plant Biosecurity, through their Education and Training program, aims to address the decline in plant biosecurity scientists, by training new scientists, and upskilling existing staff.

A three-tiered strategy has been developed to increase Australia's future capacity and core capabilities in plant biosecurity. At the first level, staff and students are offered workshops, training days and vocational courses tailored to meet specific requirements, eg workshops in new diagnostic techniques or improved risk analysis methods. A new vocational course that teaches participants about maintaining the biosecurity of stored grain is also being developed for the grains industry.

The second level of our strategy is a postgraduate Masters by coursework degree in Plant Biosecurity, which offers students eight, full semester units in the biology of plant pests, detection and diagnostics, plant biosecurity regulations, risk analysis, invasion biology, international biosecurity frameworks and community engagement.

The highest level of training that we offer is a PhD in a plant biosecurity-related discipline. PhDs are offered through eight university partners Australia-wide. We currently have forty approved PhD projects covering topics such as plant pest epidemiology, taxonomy and diagnostics of plant pests, modelling of pest and disease spread and analysis of surveillance systems.

This presentation will provide an overview of the Education and Training Program, covering the three main areas as described above.

Biography: Dr Bayliss is the Cooperative Research Centre for National Plant Biosecurity Program Leader for Education and Training. She is a plant pathologist and has worked on plant diseases affecting many crops including pastures, legumes, oilseeds, native ecosystems and plantations. Currently, Dr Bayliss is responsible for coordinating the PhD training program within the CRCNPB and develops various workshops and training days for staff and students working in plant biosecurity. Based at Murdoch University in Perth, Western Australia, she also lectures in undergraduate and postgraduate units in biosecurity.

Training the next generation of plant biosecurity professionals - the North Carolina experience

Robert Griffin, *US Department of Agriculture, Animal and Plant Health Inspection Service*

Author: Dr Stephanie Bloem, *USDA-APHIS-PPQ-CPHST-Plant Epidemiology and Risk Analysis Laboratory*

Collaboration in training the next generation of Plant Biosecurity professionals between the USDA-APHIS-PPQ-CPHST-Plant Epidemiology and Risk Analysis Laboratory (PERAL) and North Carolina State University (NCSU) began in 2004. Since that time, more than one hundred undergraduate and graduate students as well as APHIS-PPQ and University employees have enrolled in the two courses developed by PERAL - Challenges in Plant Resource Protection (3 credits) and Fundamentals of (Pest) Risk Analysis (1 credit). These two courses form part of a Minor in Plant Biosecurity and Regulatory Science at NCSU and are complemented by additional courses taught by University faculty in the areas of Entomology, Plant Pathology and Weed Science. We are developing a 1-credit Seminar series on Critical Issues in Plant Protection that will also form part of the Minor.

Through the use of live-videoconference, our educational and training efforts extend beyond NCSU and currently reach students, faculty and regulatory professionals at three additional Universities in the USA. Other international institutions have expressed interest in receiving these classes. This program directly benefits our Agency by providing a mechanism through which we can alert, inform, educate and inspire Plant Science students into careers in the area of Plant Biosecurity, Risk Assessment and Risk Management. The program has proven effectiveness as a recruiting tool, with 16 of our students now working for USDA-APHIS and other State Regulatory Agencies.

Biography: Stephanie is trained as an Entomologist. Her expertise is in the areas of Sterile Insect Technique (SIT) and area-wide pest management for several dipteran and lepidopteran pests. She has done extensive consulting in South America and Africa for the International Atomic Energy Agency in the areas of SIT and mass-rearing for moth pests. In her current position, she provides oversight to and is a lecturer for two upper-level university courses that form part of the Plant Biosecurity and Regulatory Science program at North Carolina State University. These courses are offered to other partner Universities throughout North America via live-videoconference.

Biosecurity education initiatives in the US Animal and Plant Health Inspection Service

Jennifer Nicholson, *USDA-APHIS-Plant Protection and Quarantine*

Increasing international travel and trade have contributed to a rise in incursions of exotic invasive species, which threaten agriculture and natural resources. This has caused the importance of plant and animal biosecurity to increase globally, but those outside of the regulatory agencies typically have little knowledge or understanding of biosecurity operations, or the career opportunities that are available in this area. As a tool in recruitment and outreach, the U.S. Animal and Plant Health Inspection Service has developed several cooperative programs with universities that are designed to provide an educational foundation for biosecurity, knowledge about career prospects, and potential for hands-on experience through internships. A Plant Biosecurity Curriculum has been developed by the Plant Protection and Quarantine unit, and programs for animal biosecurity have been developed by the Veterinary Services and Wildlife Services units.
Courses associated with The Plant Biosecurity Curriculum are delivered at the upper undergraduate to graduate level, and may be combined with other classes to form a minor or certificate. The Veterinary Services program is targeted to vet school students, and includes several activities, including workshops with hands-on training and a Veterinary Accreditation Program that trains students in regulatory animal health. Wildlife Services participates in cooperative teaching efforts at several universities to provide instruction to undergraduate and graduate students in wildlife damage management. The development of instructional modules and flexible delivery through videoconferencing or CDs are important tools in program delivery. These programs have been successful in educating students about biosecurity operations and in attracting students to work in the agency.

Biography: Jennifer Nicholson has been a Staff Scientist with APHIS-Plant Protection and Quarantine (PPQ) since 2007. She coordinates efforts to evaluate new science and technology, and is involved in promoting educational programs. Before joining PPQ she was an Assistant Professor in Crop Science at North Carolina State University.

Investigating plant pests just got fun! – plant biosecurity in school classrooms

Dr Kirsty Bayliss, *Cooperative Research Centre for National Plant Biosecurity* and Melanie Hay

What would plant biosecurity look like in a primary school or secondary school classroom?

The Cooperative Research Centre for National Plant Biosecurity (CRCNPB) School Education program has been developed in response to reports that indicate decreasing student enrolments in science courses at all education levels, and the increasing perception in school-aged students that science is ‘too hard’ or ‘boring’ and ‘not relevant’.

The CRCNPB has developed resources for primary (5 – 12 year olds) and secondary school (13 - 18 year olds) classrooms with the aim of engaging students in science and raising awareness of plant biosecurity.

Schools have been teaching students about plants, invertebrates and diseases for a long time, however the CRCNPB has developed innovative resources that combine learning about these three within the real world context of plant biosecurity.

This presentation will provide an overview of the CRCNPB’s School Education program and demonstrate what plant biosecurity looks like in a classroom setting.

Biography: Dr Bayliss is the Cooperative Research Centre for National Plant Biosecurity Program Leader for Education and Training. She is a plant pathologist and has worked on plant diseases affecting many crops including pastures, legumes, oilseeds, native ecosystems and plantations. Currently, Dr Bayliss is responsible for coordinating the PhD training program within the CRCNPB and develops various workshops and training days for staff and students working in plant biosecurity. Based at Murdoch University in Perth, Western Australia, she also lectures in undergraduate and postgraduate units in biosecurity.

Issues and design challenges in building a biosecure live bird market in Hanoi

John Weaver, *FAO* and Tuan Tran, *VAHIP*

Ha Vy market is the largest wholesale live poultry market serving Hanoi, Viet Nam In recent years this market has been growing steadily and now more than 100 traders handle up to 20,000 birds daily. The market facilities have been very basic with temporary stalls situated on a dyke road between paddy fields.

Under a World Bank funded HPAI control project the market is now being redeveloped into a purpose built facility. A primary objective of the redevelopment is to improve market biosecurity to reduce overall contamination, waste management, and specifically the risk of influenza viruses establishing in the market or being disbursed back from the market to the supplying traders and producers. The final market designs have been developed in consultation with market operators and traders – inevitably this has resulted in some compromises from the ideal design. The main concern of market vendors was to maintain the culture of the market with good access to the birds by purchasers. The new market is expected to begin operations in early 2010.

This paper will present design concepts for a biosecure market and discuss problems faced in gaining the support of market operators and traders and their resolution.

Biography: John Weaver is a veterinary epidemiologist working as a Chief Technical Adviser for FAO on HPAI control programmes in SE Asia for 5 years. His particular interests are surveillance systems and through the production/marketing chain risk reduction

Knowledge – the biosecurity commodity – summing up

Stephen Prowse, *Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease.*

Information is the specific commodity in which we, as practitioners in the biosecurity sector, deal with. This information may be in various forms and from a variety of sources. For example, the information may be the genetic makeup of a pathogen, it may be the prevalence of a pathogen in a geographic location, the spatial and climatic information that is related to the pathogen or it may be information that shows the presence or absence of a pathogen at a national level. The type of information is also changing with a considerable amount of “non-conventional” data available. For example, information from producers and wildlife carers can be of great value.

With the vast changes in technology, the paradigm by which we collect, consider and manage information is changing. We now have access to vastly more data than any of us could ever dream about. How do we most effectively use this vast body of information to better manage and reduce the risks of disease outbreaks? In this presentation, I will attempt to summarise and show relationships between the presentations in the knowledge stream and illustrate the importance of improved knowledge management in enhancing biosecurity.

Biography: Professor Stephen Prowse is the CEO of the Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease (AB-CRC) and an Adjunct Professor in the Faculty of Biological and Chemical Sciences at the University of Queensland. The Centre has research programs in diagnosis, disease ecology and surveillance as well as a strong focus on the adoption of outcomes, and on education and training.

Systems Stream Abstracts

(in presentation order)

The Tasmanian biosecurity system – a case study in biosecurity policy, strategy and action

Andrew Bishop, *Department of Primary Industries, Parks, Water and Environment*

Tasmania's biosecurity system is at the core of the Tasmanian Brand. Tasmania's natural environmental values and quality produce relies upon relative freedom from pests, diseases, and weeds and underpins what is known as 'island advantage'. As Australia's island state, Tasmania has a unique advantage in implementing and operating a comprehensive State biosecurity system and maintaining a regionally distinct biosecurity status. In 2006 the Tasmanian Government released its published policy on biosecurity and also the first State biosecurity strategy in Australia. The strategy was a plan to ensure an efficient and effective implementation of biosecurity policy with the primary objective being to "protect and enhance Tasmania's biosecurity status for the benefit of Tasmania's industries, environment and public well-being, health, amenity, and safety". This paper examines the policy and the strategy, reasons for their development and the critical role they now play in the operation of a State biosecurity system. The Tasmanian biosecurity system and its construction and development are described as a case study. Conclusions as to the critical importance of a sound policy base and strategic framework for the successful development and operation of a biosecurity system are then drawn.

Biography: Andrew Bishop currently manages biosecurity policy with the Tasmanian Department of Primary Industries, Parks, Water, and Environment. He was lead author of the Tasmanian biosecurity policy and Tasmanian biosecurity strategy on behalf of the Tasmanian Government via the Tasmanian Biosecurity Committee. He currently has responsibility for leading the implementation of actions detailed in the strategy to underpin and develop the Tasmanian biosecurity system. Andrew has qualifications in biology, agricultural science, and management. Over the last 25 years he has worked as a research scientist in agriculture, and been involved in technical policy/regulatory development areas associated with crop protection, weed management and biosecurity.

Biosecurity and public health: two sides of the same coin?

Mel Taylor, Beverley Raphael and Garry Stevens, *University of Western Sydney*

Both Public Health and Biosecurity are based around frameworks of policies and plans to protect, mitigate and respond to a range of threats, and both are concerned with encouraging good (healthy/safe) practice and managing emergencies and control response. Ultimately, for both, success is judged by the engagement, co-operation, and compliance of those to whom the policies are directed, i.e. people – be they farmers, producers, doctors, or the general public. The psychology of biosecurity-related behaviour; the risk analysis and heuristics people use to make protection-based judgments and how this subsequently translates into actions is of central importance, and can be used to improve the effectiveness of communication campaigns and interventions.

This presentation will address how public health research can be used to inform those tasked with implementing biosecurity policy in Australia and elsewhere; focusing on the key factors that influence compliance with protection-based behaviours and the barriers that reduce compliance and engagement. This presentation will draw on research data and lessons learned from a range of sources and emergency responses in public health, veterinary public health, communications research, and advertising. This presentation will explain human protection motivation and the role that risk perception, knowledge and awareness, cost/benefit, and personal beliefs and judgment make in driving protection-based behaviours.

Biography: Dr Mel Taylor is a Senior Research Fellow in the School of Medicine at the University of Western Sydney. Mel is a psychologist working in the area of health psychology with specific interests in risk perception and protection motivation. She has studied population compliance with health protective behaviours in the context of pandemic influenza, horse owner biosecurity response and the mental health impacts of the 2007 outbreak of equine influenza, and public preparedness for terrorism and natural hazard-related disaster. In collaboration with the University of Sydney she is also investigating the public response to human swine influenza H1N1 09.

Managing wildlife biosecurity in Australia

Lee Francis Skerratt, *School of Public Health, Tropical Medicine and Rehabilitation Sciences, James Cook University*

Whilst veterinary and human medicine is relatively proficient at managing disease, wildlife medicine is much less capable than what the public probably expects. The recent pandemic of chytridiomycosis resulting in the extinction of many amphibian species is one example demonstrating this relative inability. In addition to this general global inability, Australia trails well behind other developed countries like Canada, the USA and European countries in terms of capacity and resources to manage wildlife diseases. The unimpeded spread of Tasmanian devil facial tumour disease is an example. However, there have been some notable exceptions with regard to the control of brucellosis and TB in feral animals in northern Australia. These examples demonstrate that the potential for effective management is possible. There are two key requirements for more effective wildlife disease management in Australia. One is the need to increase resources and capacity for the Australian Wildlife Health Network which coordinates management of wildlife diseases in Australia. The second is the need to undertake research to better understand emerging diseases of Australian wildlife and how to manage those diseases more efficiently.

Biography: Lee has demonstrated that the spread of the amphibian chytrid fungus has caused the global decline and extinction of frogs (Skerratt et al. 2007) which was recently acknowledged by the World Organisation for Animal Health when they made it a notifiable disease. He has shown that sarcoptic mange is an important exotic disease in common wombats, *Vombatus ursinus*, that may cause the extinction of small isolated wombat populations (Skerratt 2005). He has identified pathogens that may be contributing to the decline of 10 of the 15 species of sea ducks in North America (Skerratt et al. 2005).

Managing biosecurity across borders: a comprehensive strategy

Professor Ian Falk, Ms Ruth Wallace, *Charles Darwin University,* Professor Kaler Surata, *University Mahasaraswati, Bali,* Dr Marthen Ndoen, *University Christian Satya Wacana, Java,* Mr I Wayan Mudita, *University Nusa Cendana, West Timor,* Mr Theo Litaay, Ms Helti Mampouw, Mr Paul Royce and Ms Sri Jayantini

What might an effective and comprehensive strategy for managing biosecurity across borders look like? ‘Biosecurity’ has become an important reality in times of the rapid spread of information, products and diseases across distances, and within and between nations. Episodic outbreaks of pandemics such as swine flu serve to bring the issue of biosecurity to global attention, especially as inter-country coordination of responses to such matters relies on enhanced cooperation and coordination. Risk management of plant and animal pests and diseases is enhanced if we can manage the risks before incursions or outbreaks occur. Such a strategy will minimise risk to and impact on industry, community livelihoods, food security and ultimately national socio-economic well-being. Australia’s proximity to South East Asia, particularly Eastern Indonesia which lies along much of Australia’s northern coastline, places strategic importance on northern Australia in terms of plant biosecurity. In Australia, this region is often managed through government quarantine services. Local communities also have an essential role in biosecurity management, and support of those communities is recognised as crucial to achieving success in managing plant biosecurity across any borders, which in turn is enabled by effective policy and governance structures. The Australian Cooperative Research Centre for National Plant Biosecurity (CRC NPB) commissioned a 6 year research project, not before addressed, to investigate how a partnership between two countries could assist manage risks concerning border security. This paper presents the findings from the mid-point of the project, and draws on a book published with Springer titled ‘Managing Biosecurity across Borders’. We present the overview of the project along with early findings on a comprehensive strategy for managing biosecurity across many different kinds of physical and social borders.

Biography: Professor Ian Falk holds the Chair of Rural and Remote Education at Charles Darwin University, Darwin, NT. Professor Falk’s more than 200 books, chapters and journal articles are in formal and informal learning, community development and well-being, social capital, learning communities, leadership, policy and adult literacy. From 2007 he has been living and working in

Indonesia where he is in charge of a major research project partnered with the Australian Cooperative Research Centre for National Plant Biosecurity into the ways communities can identify and manage issues related to their food security.

Driving science into biosecurity policy and operations

Barney P. Stephenson, Naomi S. Parker, Melissa Hume, Wren R. Green, Hazel M. Johnston and Angela R. Spackman, *MAF Biosecurity New Zealand*

The New Zealand biosecurity system has undergone substantial development over the last five years in response to the increased challenge from modern day tourism and trade, and the need for wide protection of all biologically based resources, and economic, environmental, social and cultural values. Significant effort has been devoted to enhancing the relationship between science and biosecurity from policy through to delivery. A Biosecurity Science Strategy for New Zealand was developed to provide direction for biosecurity science and to identify the actions required to influence biosecurity science outcomes for the next two decades. Investment in biosecurity science is critical: to improve the identification and definition of risks; to support the development of new policies, tools and technologies; and ultimately to stem the tide of biological invasions associated with world trade and tourism. It is essential that investment in biosecurity science is directed to the areas that will have the biggest impact on our biosecurity systems. The Biosecurity Science Strategy for New Zealand will influence science procurement at all levels, and aims to help ensure that the right biosecurity research – from the operational through to the basic – is being undertaken at the right time, that we have the necessary science capability and capacity to deliver biosecurity research, and that research outcomes are being used to improve biosecurity systems. This paper describes the approach that we are using, the progress and challenges to date, and the essential relationships that are required in New Zealand for effective delivery of biosecurity science.

Biography: Dr Barney Stephenson is a Senior Science Adviser with the Strategic Science Team of MAF Biosecurity New Zealand (MAFBNZ), providing plants biosecurity expertise. The Strategic Science Team's key areas of work include: the development and now implementation of the Biosecurity Science Strategy for New Zealand, management of a programme of contracted operational research for MAFBNZ; co-ordinating MAFBNZ engagement with Government funded research, which includes Better Border Biosecurity (B3) and other investments, and contributing to broader science engagement by MAFBNZ both within and outside New Zealand.

Regulation - a necessary evil

Merryn Pugh, *Animal Health Board, New Zealand*

The Animal Health Board (AHB) is supported in its compliance and enforcement activities by tough legislation, in the form of the NZ Biosecurity Act 1993. The Biosecurity Act is the legislation that allows for the appointment of the AHB as the management agency for the New Zealand National Bovine tuberculosis Pest Management Strategy (NPMS).

It is essential that compliance activities associated with national and international biosecurity are underpinned with tough and enforceable legislation. It is naïve to believe that individuals and companies will act compliantly because it is morally right.

As soon as there are financial incentives some individuals appear to lose sight of their moral obligations. In these circumstances regulatory agencies need the power to act and ensure that individuals and or countries are not put at risk.

The AHB manages the TB control program at a national level. Since the appointment of 2 compliance managers in 2005 it has been successful in prosecuting a number of individuals. There are other prosecutions before the courts currently and other investigations are underway, with a view of prosecution.

This presentation will outline how the AHB achieves compliance from its stakeholders and deals with issues of non compliance. It will identify how the AHB works with our farmers to ensure that legislation and policy are understood and adhered too.

A high profile prosecution of a South Island dairy farmer in 2008 received wide media attention and a great deal of support from AHB stakeholders. From initial tip off, to search warrant and prosecution there was a buzz in the farming community. The subsequent guilty pleas sent shockwaves throughout the rural sector. The success of this prosecution was made possible by appropriate legislation and penalties that are consistent with the severe loss that can be caused by the illegal actions of a minority.

Biography: Merryn has been involved with the Animal Health Board in varying capacity for 10 years. She is a cattle farmer and in 2002 became a TB tester, contracted to AHB in Canterbury New Zealand. In 2005 she moved from TB testing to the AHB to take up the position of South Island Compliance Manager, a newly created role for the AHB. She has completed my tertiary study at Lincoln University in Canterbury where she graduated with a BSc.

International biosecurity research along the quarantine continuum

Andy W Sheppard, *CSIRO Entomology*

Research underpins successful national biosecurity systems and effective international biosecurity through each step of the quarantine continuum and in the development of whole of quarantine approaches. Pre-border risk-based research assists in identifying and prioritising future threats and undertakes the preparedness activities that allow regions to protect themselves against pests prior to their arrival. Science also underpins biosecurity at the border through the development of optimal surveillance systems, detection technologies, diagnostic protocols and rapid response systems. Post border response and eradication can only be effective if underpinned by sound scientific tools and evidence-based principles and decision making. For established pests, pest containment and management are also grounded in hundreds of years of scientific principles and practices that need to be continually adapted to crops and new situations. All aspects of biosecurity systems require ongoing risk-based and science-based evaluation to ensure value-return on investments and to reliably define–issues such as pest-area freedom. Complex systems science can also assist in the development of optimal whole of industry or whole of pathway biosecurity systems, as it does for human health threats, within the context of other drivers and stressors. Research also underpins biosecurity in 21st international trade and the growth of the international bioeconomy within international and national policy frameworks. There will be many future challenges for national and international biosecurity for which only science will find the underlying solutions. Science can also provide the sound basis for international collaboration and technology transfer. This presentation will use a range of international examples from all sectors to show how science has and continues to underpin evolution of effective biosecurity systems from the point of source through to limiting the economic, social and environmental impacts in the exposed destinations. It will also look to future science needs in the face of increasing trade, tourism and global change.

Biography: Dr Andy Sheppard is a Senior Principal Research Scientist in classical biological control and the ecology of plant invasions with CSIRO and an adjunct Professor at the Australian National University and Charles Sturt University. He has worked in the field for 23 years with more than 120 international scientific publications. His key areas of expertise are a) the science of biological control for agent selection, b) understanding plant invasions through intercontinental ecological comparisons between the native and exotic ranges and c) risk analysis of the importation and establishment of exotic organisms. He has a BSc, DIC and PhD from the Imperial College London and the University of London. He has worked for CABI before joining CSIRO at their European Laboratory in France where he has worked for 10 years. He has run biological control programs against 6 target weeds with 2 successes. He has been President of CILBA Europe's largest association of biocontrol scientists. He currently runs CSIRO's national research program on invasive species prevention and management that tackles vertebrate, insect pests and plant diseases in addition to Australia's national efforts against weeds. He has been an expert international consultant on biosecurity in Europe, the USA, New Zealand and New Caledonia and represents CSIRO on Australian federal government sectorial biosecurity committees working closely with the DAFF and DEWHA

Biosecurity planning and implementation

Dr Sharyn Taylor, *Plant Health Australia*

With exotic plant pests and diseases the old adage “prevention is better than cure” holds true. Recent biosecurity incidents in Australia have included a detection of *Khapra beetle* and incursions of *sugarcane smut* and *citrus canker*. These incidents all underscore the need for efficient and effective systems and practices for early detection of pest and disease threats, as well as the importance of managed responses.

These plant pest incidents also highlight that the effective eradication or management of plant pest and disease incursions require a framework for shared decision making and cost sharing.

To this end, the Emergency Plant Pest Response Deed (EPPRD) was developed between Australian governments and plant production industries. Signatories to the EPPRD have obligations to undertake risk mitigation activities such as surveillance for plant pests and diseases, capacity building for personnel, biosecurity preparedness and improved awareness of biosecurity with the aim of providing the best prospect that new pests and diseases will be detected early and that eradication attempts will be successful.

Plant Health Australia, as well as being custodian of the EPPRD, provides assistance with these industry biosecurity activities by coordinating the development and implementation of national Industry Biosecurity Plans, incursion management and contingency plans, national and regional surveillance initiatives and farm biosecurity programs. Work will be presented on examples of the partnership approach fostered under the EPPRD to increase the uptake of these biosecurity risk mitigation activities through both government and plant industries.

Biography: Dr Sharyn Taylor joined Plant Health Australia as a Program Manager in 2007. In this role she is responsible for managing biosecurity planning and implementation projects including development, review and implementation of Industry Biosecurity Plans, the National Surveillance Strategy, the National Plant Pest Risk Mitigation Program and industry funded projects to increase biosecurity preparedness. Before Plant Health Australia, Sharyn had 16 years experience as a nematologist working in dryland cropping systems in southern Australia. In 2000, Sharyn completed a PhD on the biology of, and yield loss caused by, root lesion nematodes (*Pratylenchus* spp.) in South Australia.

National Goat Health Statement, a tool to promote on-farm biosecurity

Lorna Citer, Duncan Rowland, *Animal Health Australia*, Ian Cathles, *Goat Industry Council of Australia*, Steve Roots, *Goat Industry Council of Australia* and David Kennedy, *c/- Animal Health Australia*

Historically the management of notifiable animal diseases in Australia has been based on government regulation, with properties quarantined or movement restrictions imposed on stock that are affected. Government regulatory frameworks and policies have often reflected the needs of the more established grazing sectors such as cattle and sheep whilst, at times, the goat sector has faced severely restrictive movement requirements.

The regulatory approach to the management of endemic diseases such as Johne’s disease in a number of livestock industries was recognised as inequitable. This and producers’ reluctance to notify animal disease if the controls are considered punitive led to reviews of the sheep program and risk assessments in the dairy and beef industry and the gradual implementation of voluntary risk-based trading schemes for sheep and cattle.

This provided the opportunity for the Goat Industry Council of Australia (GICA) to also consider the benefits of developing a national goat health statement based on animal health risk assessments for several important disease including lice, footrot, Johne's disease, Caprine Arthritis Encephalitis (CAE) and resistant worms.

The improved biosecurity in the management of endemic disease has the capacity to improve farm productivity and establish on-farm practices that better prepare producers to manage if a disease event occurred.

The Australian goat industry has recently developed the *National Goat Health Statement* as a tool for managing on-farm biosecurity, based on the assessment of animal health risk for a number of diseases and to facilitate trade between jurisdictions and individual properties.

To support the introduction of the certificate, GICA undertook a targeted promotional campaign which included the development of a customised website, and extension materials promoting risk assessment prior to purchase. The role of the goat health statement as a risk management and biosecurity tool is also promoted through a link to the National Farm Biosecurity website. (http://www.farmbiosecurity.com.au)

Biography: Duncan works for Animal Health Australia (AHA) as Manager, Disease Risk Mitigation with responsibilities for TSE Freedom Assurance Program, NLIS (all species), biosecurity planning with industries and government. He is the AHA representative on SAFEMEAT Executive, NLIS monitoring committee and management committees for industry NLIS programs. Prior to joining the company he worked in the Australian feedlot industry working on the eastern seaboard for 3 companies in positions ranging from Assistant Operations Manager to General Manager, and for the Victorian Department of Natural Resources and Environment with responsibility for programs aimed at growing the Victorian feedlot industry whilst meeting sustainable environmental objectives.

Response management: one system to rule them all

Presented by David Hayes

Authors: Amelia Pascoe, Sarah Clinehens and Kevin Sloan, *Biosecurity New Zealand, Ministry of Agriculture and Forestry*

The Ministry of Agriculture and Forestry Biosecurity New Zealand (MAFBNZ) is responsible for leading and coordinating biosecurity responses in New Zealand across all sectors, and in all environments. This includes responding to risks from new pest and disease incursions, and from established pests that present potentially significant new or emerging threats. Since MAFBNZ took on this role in 2004, it has managed a wide range of responses - from large to small - in the marine, terrestrial and freshwater environments, and to pests, diseases, and risk goods affecting people, the environment, and the economy. Historically MAFBNZ has taken a sector based approach to response preparation and management. However, picking up on best practice and lessons learnt from this broad range of responses MAFBNZ has recently developed and is now using new generic response system that applies a consistent approach to all responses, regardless of the nature of the risk or the sectors potentially affected. The response system includes a new policy for MAFBNZ responses to risk organisms, that sets expectations for MAFBNZ in readiness and response; a response project team structure compatible with the Coordinated Incident Management System used in other parts of government, so that other agencies can easily work with us; a web based system of processes, procedures, tools and templates to support a consistent approach; and system to develop a sustainable pool of capable people to lead and manage responses. The new system has been successfully tested in numerous responses over the last 18 months, most recently in a multi-agency response (involving both central and local government) to a well established but emerging disease threat. This presentation introduces the key elements of the system, the benefits already realised, and plans for the future.

Biography: Amelia leads the MAFBNZ team responsible for preparing for and responding to pests and diseases incursions affecting plant health. Amelia joined MAF in 2000, to set up and run a new program of work for responding to pest incursions threatening native biodiversity, human health and wellbeing. This included managing New Zealand's first two red imported fire ant eradication programs, establishing a nationwide invasive ant surveillance program and initiating MAFBNZ's response to Didymo. More recently Amelia has taken a key role in a project team to describe a desired future state for cross-MAFBNZ response readiness, including development of a three-year plan to deliver this.

An overview of the Emergency Plant Pest Response Deed (EPPRD)

Rodney Turner, *Plant Health Australia*

The Emergency Plant Pest Response Deed (EPPRD) is a legally binding agreement between the Australian Government, all State and Territory Governments, plant industries, represented by national peak industry bodies, and Plant Health Australia (PHA). The agreement is a world first for the plant sector, being operative from 26 October 2005.

The EPPRD was based on the Emergency Animal Disease Response Agreement, (EADRA) which was the world first agreement of its type. The EPPRD replaces the previous informal arrangements regarding consultation and financial contribution to response costs by beneficiaries of the eradication effort. It provides a structure for consultation and decision making by Signatory organisations in relation to Emergency Plant Pest (EPP) eradication responses, and a pre-agreed basis for the sharing of costs related to these responses. It also provides mechanisms to provide incentives to all participants to be involved in biosecurity risk mitigation including participation in early detection and early reporting of Pests that are exotic to Australia. The EPPRD offers the potential for Owner Reimbursement Costs to be paid to growers of a Signatory industry who has their crop destroyed as a result of the implementation of an approved eradication response.

Another benefit of the EPPRD is that all governments are Signatories, so responses to EPPs are coordinated from a national level and there are nationally agreed processes for dealing with incursions. As a truly national agreement, a platform has been created for more planning and development of response options prior to incursions. These are reducing the time taken to implement response operations. This includes the development of diagnostic protocols and contingency plans for EPPs.

Biography: Rodney Turner is PHA's General Manager - Programs. Rod has wide experience across all PHA activities ranging from technical experience in emergency plant pest management, representation on National Committees, business planning and development, Member liaison and leadership across the Company's Programs area. Prior to joining PHA in 2002, Rodney was a Senior Program Manager at Australian Quarantine and Inspection Service. Rodney has extensive experience in the management of AQIS's Horticulture and Grains Import and Export Programs, the Post Entry Plant Program and managing AQIS's field based plant pathologists and entomologists. Rodney also has experience in developing national operational policy involving international negotiations.

Subcommittee on plant health diagnostic standards

Barbara Hall, *South Australian Research and Development Institute*

In 2004 a new “committee on plant diagnostics and laboratory accreditation” was formed as a subcommittee of the national Plant Health Committee (PHC) to facilitate activities that will enhance Australia’s plant biosecurity. Called the Subcommittee on Plant Health Diagnostic Standards (SPHDS), the primary goal was to “establish, implement and monitor professional and technical standards within plant health diagnostic laboratories through the development and maintenance of an accreditation system and national diagnostic protocols”. Achievements so far include the development of an accreditation system under ISO/IEC 17025, administered by the National Association of Testing Authorities (NATA). Known as the Plant Health Diagnostic Testing Annex to the Biological Testing Field Application Document, this accreditation will assure the quality and integrity of the results produced and provides confidence to biosecurity administrators in managing biosecurity incidents and emergencies. The second main achievement is the development of a process to provide National Diagnostic Protocols to be used for the detection and identification of plant pests. Reference standards have been developed to assist potential authors develop diagnostic protocols by providing a standardised format and a process for assessment, involving technical verification in Australian conditions and peer review, before endorsement by PHC as a “National Diagnostic Protocol”. Two protocols were endorsed in 2008 and another 5 are expected to be endorsed in 2009. This paper illustrates the achievements of SPHDS and discusses the future challenges involved in improving the diagnostic capacity and capability within Australia, including the development of protocols for the 250 or more plant pests identified by Australian plant industries as high priority and development of a National Diagnostic Strategy for plant health as an element of the National Plant Health Strategy.

Biography: Mrs Hall is the chair of the Diagnostic Standards Working Group of SPHDS, and is representing the members of the subcommittee

Biosecurity surveillance problems are typically complex and require an integrated design approach: a solution

Peter Whittle, Sue Barrett, Frith Jarrad, Kerrie Mengersen, *Queensland University of Technology and Cooperative Research Centre for National Plant Biosecurity*, Justine Murray, *Cooperative Research Centre for National Plant Biosecurity* and Richard Stoklosa, *Chevron Australia*

Biosecurity surveillance problems are typically complex, with multiple threats, heterogeneous risk surfaces and arrayed detection methods. Available design techniques do not deal with complexity and instead attempt to reduce it, by designing for single threats by a single detection method, or ignoring statistics and designing to budget or other pragmatic considerations. We were challenged to design a statistically based surveillance system (SS) for a complex application and developed a design method that has potential for broader use.

The context is a high-value island nature reserve where a major industrial development has been approved, contingent *inter alia* on a detection program having power (probability of detection given presence) of 80% for non-indigenous species (NIS) of invertebrates, vertebrates and plants. The method addresses typical design complexity as follows:

- To account for a great range of threats, design SSs for several exemplar species, each comprising several detection methods ("SS components" (SSCs)), including traps, surveys and worker observations
- Use expert elicitation to address data gaps
- Calculate detection power of each SSC, for exemplar population sizes of acceptable risk
- Array the SSCs together, taking account of their individual power and broad cost, into an optimised exemplar SS having 80% power specification
- Use risk-mapping to narrow the sampling frame and deploy each SS efficiently
- Overlay exemplar SSs to develop an efficient, integrated SS for all potential NIS
- Give responsibility to surveillance staff for temporal and spatial deployment at local level, to achieve further risk-targeting.

Implementation has commenced and further desktop and field studies will examine robustness and validity. Designs will be adapted as data are acquired and analysed. We describe the design method and its application in this case study and in a new project with an agricultural setting.

Biography: Dr Peter Whittle is a plant pathologist experienced in a range of biosecurity activities including risk analysis, policy and regulation, emergency response, diagnostic systems, epidemiology and aspects of preparedness. His present work as Principal Research Fellow at Queensland University of Technology is with a team of statisticians and biologists to design surveillance systems for complex biosecurity settings. The team, under Prof Kerrie Mengersen, also works with risk analysis and other quantitative biosecurity problems.

Biosecurity surveillance design for invading species: updating expert estimates with experimental data

Frith Jarrad, Peter Whittle, Sue Barrett, Kerrie Mengersen, *Queensland University of Technology and Cooperative Research Centre for National Plant Biosecurity* and Richard Stoklosa, *Chevron Australia*

Complex surveillance problems are common in biosecurity, for example specifying risk over a heterogeneous landscape, combining multiple sources of surveillance data, and designing for specified power to detect. Moreover, when designing for multiple target species, inherent biological differences among species result in different ecological models underpinning the individual surveillance systems for each. Species are likely to have different habitat requirements, different introduction mechanisms and

locations, require different methods of detection, have different levels of detectability, and vary in rates of movement and spread. Often design of biosecurity surveillance systems is constrained by a lack of empirical data. One way to overcome this constraint is by using expert elicitation for assessing design and estimating values for model inputs. Expert estimates have inherent uncertainty, which may impact on design outputs. For important and influential but uncertain estimates it is ideal to refine them through experimentation where possible.

The study area is a conservation reserve, where industrial development poses a biosecurity risk due to the potential introduction of non-indigenous species. To address the issue of detecting a small number of individuals of a non-indigenous species, a statistically based surveillance design method was developed, which is novel in that it addresses a range of challenges not previously met altogether in one comprehensive surveillance design. Overall, the surveillance design method allows for an efficient use of resources, achieves specified power to detect incursions, and assists to manage environmental and financial costs. The design method has been applied to invertebrates, plants and vertebrates and has the flexibility to be applied to various complex surveillance applications, and to continuously evolve as data is collected as a basis for adaptive management. We discuss the ecological basis for the design, and outline a pilot study which aims to refine the design through experimentation, using rare native species as surrogates for detecting invasive species in the early stages of invasion.

Biography: Dr Frith Jarrad is a Research Associate with the School of Mathematical Sciences at the Queensland University of Technology, Brisbane, Australia, currently working on invasive species and surveillance design. She recently received her PhD at the University of Melbourne on the topic of climate change and fire impacts on alpine plants, and broadly her areas of interest are ecology and conservation biology.

PaDIL – innovation in delivering biosecurity to end users

Ken L. Walker, *Museum Victoria*

The public profile of Biosecurity has increased dramatically in recent years to a broader user base of farmers, exporters, Local, State and Federal Governments as well as general community groups. The non-Government user base is called Citizen Science which can make valuable contributions to Scientific Biosecurity knowledge. To make effective use of these new resources, Biosecurity needs to provide user friendly delivery outputs. Cultural networking has taken the communication world by storm so why not adapt it to meet the needs of Citizen Science networking. Two strategies are required to build such networks: There should be multiple entry points into the datasets – ie. Faceted Searching; Data outputs must be engaging and interactive and offer a “one-stop-data-shop”. Users want to construct their own queries, data mine in their own directions, seek character analysis assistance, tag data and offer feedback. Pivotal to such networks is ease of access to the data via a web browser and a data return motto of “Speed Matters”. PaDIL – Pests and Disease Image Library http://www.padil.gov.au - is an example of a Biosecurity and Quarantine Incursion Management website moving in these Citizen Science directions. The initial PaDIL outputs were designed to build capacity for Government Biosecurity related needs, but more recently PaDIL has been delivering Quarantine Incursion Management assistance to the Barrow Island “A-class” nature reserve.

Biography: Ken Walker is the Senior Curator of Entomology and Deputy Head of Science at Museum Victoria, Melbourne Australia. By their very nature, Museums have enormous datasets that can numb and bewilder the minds of the scientists, let alone members of the public trying to use them. Ken has a strong interest in effectively delivering the results of scientific endeavor to the Citizen Science community.

Improvements to biosecurity responses in New Zealand

Sarah Clinehens and Amelia Pascoe, *Ministry of Agriculture and Forestry Biosecurity New Zealand*

The Ministry of Agriculture and Forestry Biosecurity New Zealand (MAFBNZ) leads a biosecurity system to protect New Zealand’s people, environment, and economy from risk organisms. MAFBNZ responds to organisms in agricultural, environmental, and urban settings. Responses have included southern saltmarsh mosquito, “kauri die-back”, Mediterranean fan worm, and varroa bee mite. This

presentation addresses how learning from these and other responses have helped MAFBNZ to improve, response decision-making, engagement with stakeholders, and surveillance and planning for responses. MAFBNZ has replaced policies and procedures for each sector with one generic system for responses of all sizes in all sectors. This is improving the speed and quality of decision-making and ensures a consistent and transparent approach. MAFBNZ often faces multiple incursions that draw upon its limited resources. MAFBNZ has improved its methods for comparing response priorities and evaluating response options using cost benefit analysis and assessment of feasibility and likelihood of success. This has helped MAFBNZ to make tough decisions, for example on whether to continue the eradication programme for southern saltmarsh mosquito and how to manage varroa bee-mite. From 2002 to 2004, MAFBNZ aerially sprayed an urban area with an organic insecticide to eradicate the painted apple moth. Some in the community feared that the spray could harm them, and opposed the operation. In subsequent responses, such as kauri die-back and Mediterranean fanworm, MAFBNZ has moved more quickly to consult with communities, Maori, and other groups and involve them in developing response options. Good response planning and adequate surveillance for early detection reduces the risk of costly responses. MAFBNZ has readiness work underway on a surveillance strategy; policy and tools for implementing movement standstills; and identifying where capability lies throughout New Zealand for performing field operations.

Biography: Sarah Clinehens is a Senior Policy Analyst for the Ministry of Agriculture and Forestry Biosecurity New Zealand (MAFBNZ). Since joining MAFBNZ in 2005, Sarah has provided policy support for incursion responses and helped develop the *Policy for MAF's Responses to Risk Organisms*. Working closely with primary industries, she has helped develop proposals for a Government-industry agreement for joint decision-making and cost sharing for readiness and response.

Equine influenza eradication – lessons for future responses

Ron J Glanville, *Biosecurity Queensland*

In August 2007 equine influenza (EI) was diagnosed in Australia's horse population following the failure to contain infection in the quarantine system after the importation of infected horses. The subsequent response was the single largest animal disease emergency in Australia's history.

Australia has well developed plans for responding to an outbreak of an emergency animal disease including the *Government and Livestock Industry Cost Sharing Deed in Respect of Emergency Animal Diseases* and the Australian Veterinary Emergency Plan (AUSVETPLAN).

Eradication was highly successful, based on strict movement controls, surveillance, vaccination and an extensive communication program. Over the four month period of intensive operations the direct costs were over $340 million. The last known clinical case was on 25 December 2007, with provisional freedom declared on 14 March 2008 and freedom on 30 June 2008. Surveillance continued until the end of 2008 to satisfy World Animal Health Organisation (OIE) requirements.

However the EI outbreak and associated response presented a range of challenges in a complex, fragmented and dispersed horse industry that had little previous contact with government or knowledge of emergency response arrangements. Many of these challenges could not be fully anticipated or planned for.

There is a difference between "routine" emergencies and true crises. Routine emergencies can be managed through properly considered plans, systems and training. Crises are characterised by significant novelty, uncertainty, public profile and extreme strain on existing systems.

Within this context, the EI outbreak was a true crisis. Responding agencies needed to be flexible, adapt and improvise within existing plans, invent new strategies, create new innovative techniques, and at times reframe existing paradigms.

Lessons learnt will be discussed within this context, particularly in relation to lessons that can be applied generically to future pest or disease outbreaks.

Biography: Dr Ron Glanville, B.Sc.; B.V.Sc.; M.V.S. has had 32 years of experience in leading and implementing biosecurity programs in Queensland. In his current position of Chief Biosecurity Officer and Chief Veterinary Officer within Biosecurity Queensland, Ron is responsible for leading and managing biosecurity policy and operations for the State across a range of sectors. These include animal and plant pests & diseases, chemical use & food safety, animal welfare and invasive plants & animals.

Biosecurity perceptions of horse owners and managers in New South Wales and their attitudes towards a potential future outbreak of equine influenza

Kathrin Schemann, Simon Firestone, Jenny-Ann Toribio, Michael Ward and Navneet Dhand, *University of Sydney* and Melanie Taylor, *University of Western Sydney*

The 2007 outbreak of equine influenza caused a substantial financial and emotional disruption. Perceptions are recognised as an important factor in predicting behaviour. Knowledge of biosecurity perceptions is important for authorities in order to influence voluntary compliance with biosecurity recommendations through extension activities. As part of an independent, unmatched case control study involving 200 horse premises from highly affected regions of NSW, we determined horse owners' and managers' biosecurity perceptions and attitudes towards a potential future outbreak of equine influenza in Australia.

Case and control properties were randomly selected from lists of infected and non-infected properties obtained from NSW DPI. Face-to-face interviews were conducted including questions about the stringency of biosecurity measures taken and information sources used during the 2007 outbreak of equine influenza and about attitudes towards a potential future outbreak.

Of the 200 properties investigated, 127 had at least one confirmed case of equine influenza infection whereas 73 were never infected. The majority of horse owners and managers (67%) believed that their biosecurity measures were more stringent than normal during the time of the outbreak.

The major information sources used by the owners and managers during the outbreak were NSW DPI (92%), the internet (77%), veterinarians (74%), other horse owners (70%), TV (61%) and radio (50%).

About 92% of those owners and managers using the NSW DPI as an information source thought that NSW DPI provided useful information about controlling the spread of equine influenza. Similarly, 93% of those receiving information from a veterinarian considered it useful.

Of all the participants, 67% felt vulnerable or very vulnerable to another potential outbreak, but 86% felt broadly prepared. Of all respondents, 52% deemed another outbreak of equine influenza in the next five years as likely or highly likely.

Acknowledgements: This research was funded by Rural Industries Research and Development Corporation (RIRDC).

Biography: Kathrin is an animal scientist and currently a PhD candidate at the University of Sydney in Veterinary Epidemiology. She undertook an honours research year for her Animal and Veterinary Bio Science degree in 2008. Her honours work was supported by the ABCRC and comprised an assessment of the disease surveillance activities for pigs at abattoirs and saleyards in New South Wales. Currently, Kathrin is investigating biosecurity perception and practices of horse owners and horse industry participants and the policy implementation process during the 2007 equine influenza outbreak.

A smutty story – lessons from an incursion of sugarcane smut

Barry Croft, Rob Magarey and Peter Allsopp, *BSES Limited* and Bernard Milford, *Canegrowers*

An incursion of sugarcane smut *Ustilago* (*Sporisorium*) *scitaminea* into eastern Australia in 2006 triggered the first plant industry response covered by the Emergency Plant Pest Response Deed (EPPRD), an agreement between government and industry for handling an incursion of an exotic plant pest. The sugarcane smut fungus produces a whip-like structure from the heart of the sugarcane plant and causes severe stunting in susceptible cultivars. Smut has a history of spread around the world and was found in the Ord River Irrigation Area of Western Australia in 1998, only two years after the sugar industry was established in this region. The spores of the fungus can travel long distances on the wind and it is thought the disease spread to WA from Indonesia. The sugar industry on the east coast of Australia had been preparing for an incursion of smut before the incursion in WA but increased its preparations after this incursion. Smut was found near Childers in southern Queensland in June 2006. In November and December 2006, the disease was found in Central and North Queensland and was declared established and widespread. Eradication and containment were not possible. The incident definition stage is important in the success or failure of any attempts at eradication or containment of a

disease. The aim of the EPPRD was to define, before an incursion, the responsibilities of each level of government and of industry and to clarify arrangements for compensating growers who are required to take action to control the disease. Modelling of spread of the pest, likely losses and the economic impact of the disease are difficult during the emotive period after an incursion, but are necessary to ensure that the response is likely to be cost effective. This paper will explore the lessons learnt from a major incursion of a serious plant disease from the perspective of the sugar industry.

Biography: Barry Croft has worked as a sugarcane pathologist for 30 years based in Brisbane, Tully and Woodford. He graduated with a degree in agricultural science from the University of Melbourne in 1979 and gained a Masters Degree in Agricultural Science from the University of Queensland in 1989. He has extensive experience with sugarcane diseases in many countries.

Rabies on the move in Indonesia - lessons for Australia

Dr Helen Scott-Orr, *New South Wales Department of Primary Industries*

Rabies was historically endemic in the larger islands of Indonesia, but eastern Indonesia was free of the disease. However in the last 14 years it has been spreading slowly and insidiously in the eastern part of the Indonesian archipelago despite long term attempts to prevent this. Recent rabies incursions include into Flores in 1997, Maluku in 2003, North Maluku in 2005 and most recently Bali in 2008.

The response of Indonesian authorities to the Flores and Bali incursions and the impact of these responses on the subsequent rabies incidence on each island will be discussed. In each case, major efforts to eradicate the disease have been unsuccessful to date, and both significant extra resources and innovative approaches will be required to have any prospect of success. As well as this, the reasons for rabies spread within Indonesia are discussed, and the prospects for further extension to Papua and thence down to the Torres Strait are canvassed. If it entered, rabies could wreak havoc in the Top End among remote communities with many unrestrained dogs.

The ineffective rabies control responses in Flores and Bali have shown that a number of pre-requisites are required to mount a rapid and effective response to a rabies incursion into a previously rabies free area. Currently, Australia lacks many of these. A major revision of Australia's rabies response strategies would be appropriate, in view of the slow but steady eastwards progression of rabies in Indonesia's Eastern Islands.

Biography: Helen Scott-Orr has a long experience in biosecurity system management and improvement and agricultural and veterinary research management. She was NSW Chief Veterinary Officer for 9 years at an early stage of AUSVETPLAN development, and currently leads an ACIAR project "Improving veterinary service delivery in a decentralised Indonesia". She is also a Board Director of the CRC for Australasian Invasive Animals.

Risk factors for the spatial-temporaldistribution of Tabanus (Family: Tabanidae): a cart analysis

Kirsty Moynihan, Lee A. Fitzpatrick, *School of Veterinary and Biomedical Sciences, James Cook University*, Rhondda E. Jones, *School of Marine and Tropical Biology, James Cook University*, Lee F. Skerratt, *School of Veterinary and Biomedical Sciences, James Cook University* and Ray Muller, *School of Public Health and Tropical Medicine, James Cook University*

Performing analysis of risk in the field of biosecurity can be difficult, especially finding a robust and simple tool that explains the associations between ecological variables.

In cases where there is little available data and extrapolation of available data can be problematic, a potential tool to consider is Classification and Regression Tree (CART) analysis.

Relationships between ecological data are often complex and involve interactions. CART analysis is well suited to ecological data, where it can be used to describe and predict patterns and processes. This tool has the benefit of being able to work with a broad range of data types, has simple and robust construction, can handle missing values and is simple to interpret.

Classification and Regression Trees (Brieman *et al* 1994) have been used in a wide variety of applications including highway safety analyses, credit scoring and health applications such as low birth weight analysis and evaluation of chest pain. It has also been used to reliably predict tree mortality from the trap catches of spruce beetles and to correlate trap catches with endemic and epidemic conditions, indicating applicability to biosecurity scenarios.

Here, the spatial and environmental factors associated with prevalence of insect vectors of surra are examined using CART analysis. CART analysis indicates that the highest prevalence of the insect genus of interest, *Tabanus,* occurs where vapour pressure exceeds 22.6 hPa, and where vapour pressure was above this level, areas north of latitude 12.3 ° S (above Weipa) were also associated with higher prevalence. This means *Tabanus* is most often present during the months from October to June in latitudes north of Weipa. Next highest prevalence occurs south of Weipa during the months of January, February and March (when vapour pressure exceeds 30 hPa). This distribution is consistent with the results of GIS mapping of *Tabanus* spatial abundance patterns. Applications of this analysis are discussed.

Biography: Kirsty Moynihan completed her PhD on ecology of tabanid flies and their potential as vectors for Trypanosoma evansi in 2007. She has worked for the Department of Agriculture and Food, Western Australia, in biosecurity & product integrity policy roles for the past 2 years.

How can research inform policy in weed incursion management?

F. Dane Panetta, *Biosecurity Queensland*

Good science should underpin decision making at all stages of weed incursion management (WIM). Critical stages in WIM include the selection of an appropriate response strategy, evaluation of strategy performance and judgment regarding whether (and when) an alternative strategy should be adopted. This paper will focus upon one particular WIM strategy, i.e. eradication. The first decision regarding this strategy is whether eradication is, in fact, a feasible objective. While many disparate factors need to be considered, feasibility cannot be divorced from the investment required to achieve this objective. Two research approaches have been applied to the problem of estimating investment. Regression analyses have been based on the details of actual eradication programs, but suffer from a number of drawbacks, most significantly the small number (and small sizes) of successful programs to draw upon. Statistical approaches to estimating the effort required for weed eradication are thus not particularly informative and are not likely to become so in the foreseeable future. Other modeling approaches, based upon key aspects such as weed detectability and biological characteristics, in conjunction with search effort, appear to show more promise. Evaluation of the performance of weed eradication programs has required the definition of key criteria and the development of measures of conformity with these. The definition of critical decision points and how to apply conformity measures remain problematic, but the application of 'switching point' theory may be useful in this regard. Finally, in the absence of reliable estimates of maximum seed persistence, recent research concerning when to stop looking for an eradication target has provided an economically based rationale for this decision.

Biography: Dane Panetta has 35 years' research experience in the field of weed ecology, both in agricultural systems and natural ecosystems. He has had sustained involvement in matters relating to weed risk assessment and policy issues concerning on-ground management of a range of weeds. His recent research has focused on weed eradication feasibility and the evaluation of weed eradication programs. Dane is currently Professional Leader at the Alan Fletcher Research Station in Biosecurity Queensland. For a number of years he also led a research program ('Weed Incursion and Risk Management') in the Cooperative Research Centre for Australian Weed Management.

A way to weigh dread weeds - a policy framework to estimate the costs and benefits of commercially valuable invasive species

Dr Stephen Johnson, *New South Wales Department of Primary Industries*

Decision making is all about weighing up costs and benefits. There are many ways we can use policy to regulate for the worst **and** anticipate the best in the development of plant industries.

Increasingly, there are calls for 'comprehensive cost:benefit analyses' to support such policy. The many cost:benefit analysis tools available are highly effective ways to do this. Having said this, these tools require good information that is often costly and time-consuming to research. This situation still applies even if analyses are done for a range of representative plant species.

More often than not, information on the costs (negative impacts) and benefits (positive impacts) of a species is unclear, or simply not known.

What can be done in these cases?

How can we use policy to balance our protection of the community, primary industries and the environment (the triple bottom line) from the worst of the impacts while ensuring that we get the best results for all?

This paper proposes a policy framework (based on a decision table) by which positive and negative impacts can be weighed. The framework can be used to guide decision making whether one has a minimum or full set of information. This semi-quantitative framework uses a best-practice international weed risk management systems, allowing for the recording of assumptions, for continual monitoring, review and reassessment and for communication of these results to stakeholders, whether these be from industry, policy, research areas, or the ultimate decision makers.

While the framework is based on one risk assessment system, other systems can be substituted in to weigh impacts in a similar manner. Likewise, while the paper uses invasive plants as an example, the system applies equally to invasive vertebrates and invertebrate biosecurity threats.

Biography: Dr Stephen Johnson works for the New South Wales Department of Primary Industries at their Head Office in Orange where he has spent the last 5 years as a weed risk assessor and weed ecologist.

Stephen trained at the University of New England as a botanist and plant ecologist and at Central Queensland University as a crop agronomist. Aside from his considerable experience in grazing systems in high and low rainfall zones and in dryland cropping, Stephen spent nearly 9 years as a research scientist in irrigated cropping systems.

Australia's Weeds of National Significance program: achieving the biosecurity continuum

Hillary Cherry and Peter Turner, *Department of Environment and Climate Change*

The Weeds of National Significance (WONS) Program is a joint initiative between the Australian Government and all States/Territories that provides for effective pre- and post-border prevention, containment and management of 20 widespread weeds. Since inception in 1999, the program has fostered national coordinators, supported by cross-jurisdictional management groups, to develop and oversee implementation of a national strategy for each weed. Strategies were developed in consultation with all stakeholders and these same partners remain instrumental to strategy implementation. Program governance is nested under existing national and state committees, negating the need for a separate governance stream. The model allows coordination of post-border containment across jurisdictions, with the majority of action often occurring at local and regional levels. This approach is effective in preventing further spread of the weed through containment and regional eradication programs that are supported by targeted awareness campaigns. In addition, cost-effective, post-border management of core infestations is achieved through strategic prioritisation processes that target protection to high-priority biodiversity and primary production assets, thus reducing the impact of these widespread weeds through a whole-of-government approach. This paper presents examples from four WONS programs (bitou bush and boneseed, lantana, blackberry and parthenium weed) to illustrate the effectiveness of this model as a tool to contain and reduce the impacts of post-border biosecurity threats. To highlight the biosecurity approach undertaken for WONS, management strategies for two of these widespread weed species are compared to those of the Pandemic H1N1 (swine flu).

Biography: Hillary Cherry is the National Bitou Bush and Boneseed Coordinator, working with the NSW Department of Environment and Climate Change and the Weeds of National Significance Program. She is originally from Florida, where she has worked with such notorious Australian invaders as Casuarina, Melaleuca and Lygodium. She has a Master's Degree in Botany from the University of Florida and

worked with the University of Florida's Center for Aquatic and Invasive Plants on terrestrial weeds before moving to Australia in 2002, only to end up working with South African weeds.

Improving the integrity of exotic plant pest surveillance data with hand-held (PDA) computers

Robert Emery, Nicolas Garel, Michelle Chami and Darryl Hardie, *Department of Agriculture and Food Western Australia*

Australia remains committed to the World Trade Organisation agreement, the Sanitary and Phytosanitary agreement and the International Plant Protection Convention and its associated International Standards on Phytosanitary Measures and recognises the need for quarantine plant pest surveillance data of the utmost integrity is essential to support Area Freedom negotiations.

With most of Australia's agriculture produce exported, securing and maintaining market access is critical as is the need to demonstrate freedom from certain plant and animal pests and diseases. Surveillance is an important tool for securing market access and accordingly exporting countries now need to provide accurate, credible evidence to confirm absence (*i.e known not to occur*) for pest freedom status.

In the past nearly all field collected surveillance information was recorded manually to paper reducing the rate of capture, integrity, conformity as well as security of the data. This Cooperative Research Centre for National Plant Biosecurity (CRCNPB) project focussed on the development of pest surveillance data collection software and hardware using hand-held computers or PDAs (Personal Digital Assistants). This approach provides chain of evidence control, increases the volume of data collected as well as its integrity through relational databases and seamless data transfer to corporate systems.

CRCNPB PDA software developed with Visual CE was successfully trialled during the 2007 post-border detection of Khapra beetle by providing evidence of complete eradication via 1,273 trap inspections. This achievement was supported by GPS-located traps, digital voice navigation itineraries, digital time and date stamps, field printed barcode labels, site imagery, Google Maps integration, all in a single hand-held unit.

New PDA hardware and software is under development by the CRCNPB for use in other pest surveillance activities. These include, hazard site pest surveillance, stored grain fumigation monitoring, grain insect resistance testing and fruit fly phenology studies.

Biography: Mr Rob Emery has over 30 years of service with the Western Australian Department of Agriculture and Food (DAFWA) where he has investigated broad spectrum economic entomology. For the last 25 years he has led the Department's Stored Grain Research Group primarily monitoring and managing phosphine resistance. His interest in Information Technology came through entomological database development and delivery over the Internet. Mr Emery's current research is supported by the Co-operative Research Centre for National Plant Biosecurity with whom he has projects on handheld computers for field surveillance data collection, remote diagnostics, Internet plant pest surveillance and grain insect resistance.

Prospects for developing a mass-rearing facility for fruit fly parasitoids in Australia: an international viewpoint

Olivia L. Reynolds, *EH Graham Centre for Agricultural Innovation, New South Wales Department of Primary Industries*, Andrew Jessup, *Insect Pest Control Sub-programme, FAO/IAEA Agriculture and Biotechnology Laboratory*, Jennifer Spinner, *Cooperative Research Centre National Plant Biosecurity and EH Graham Centre for Agricultural Innovation, Charles Sturt University* and Geoff M. Gurr, *EH Graham Centre for Agricultural Innovation, Charles Sturt University*

This paper describes an investigation and outcomes of the feasibility of developing a parasitoid mass-rearing facility in Australia. In order to understand the complexities that may be encountered, an international study tour of Central (Guatemala) and North (Mexico, Florida & Hawaii) America was undertaken by Professor Geoff Gurr, Dr Olivia Reynolds and postgraduate student Jennifer Spinner in

June 2009. The purpose of the tour was a) to obtain first-hand knowledge and skills in mass-rearing techniques and quality management of fruit fly (Diptera: Tephritidae) and parasitoid wasp (Hymenoptera: Braconidae) mass-production, (b) to study techniques used for the inundative release of parasitoid species used in the Americas (which include Australian species) and c) to bring back this knowledge and assess the possibility of developing a parasitoid mass-rearing facility in Australia. In Mexico alone, over 50 million parasitoids are produced per week for shipment and release to the Guatemalan/Mexican border and Florida as part of a preventative release program to control fruit fly. In mass-rearing facilities, the quality of the fruit fly host, the age of the host when presented to the parasitoid and the maintenance of a hygienic environment to minimise disease and fungal contaminants are crucial to ensure maximum parasitism is achieved. Parasitoid species are often chosen based on three main factors: i) ease of rearing, ii) cost of rearing and iii) levels of parasitism reached in the field. Seventy percent of costs are related to mass-rearing the fruit fly, while 30% are attributed to the parasitoid rearing. The presence of a fruit fly factory in Australia means that we have a source of host material; however the labour costs could prove a constraint. Automated systems may assist in reducing such labour costs. Outcomes from the study tour are presented in the context of the parasitoid mass-rearing facilities viewed and the lessons learned from our international colleagues for establishing and maintaining such a facility.

Biography: Dr Olivia Reynolds is a Research Scientist with the EH Graham Centre for Agricultural Innovation (a collaboration between NSW Department of Primary Industries and Charles Sturt University). Olivia currently has two main programs of research. One on the use of non-chemical control tactics to manage native and exotic fruit fly incursions, the other on the role of silicon and induced plant defence. Olivia sits on the EH Graham Centre Rural Management Committee and is a foundation member of the Australian Bio-Protection Initiative. Olivia is a current member of the National Fruit Fly Working Group and the NSW DPI Fruit Fly Research and Technical Team. Olivia is also an editor for the international quarterly bulletin, *Fruit Fly News.*

Survival Limits for Mediterranean fruit fly

C. P. Francis De Lima, *Department of Agriculture and Food Western Australia*

Data at lower and upper temperature limits in Western Australia and elsewhere were used to develop survivorship models from primary data obtained from controlled field and laboratory experiments. A thermal time model was developed to predict development of Mediterranean fruit flies (MFF) in host fruit and survival in varying environments based on monitoring insect numbers in hosts. The likely geographical extension of habitat as a result of climate change is estimated. This information is used to assess new areas at risk from MFF establishment through incursions and the likely success of eradication efforts.

Biography: Dr De Lima has worked for 25 years internationally and in Australia on the ecology and area wide management of the Mediterranean fruit fly, developing monitoring systems for area freedom and validation of eradication of outbreaks.

Multidisciplinary design and flight testing of a remote sensing airborne biosensor

Dr L. Felipe Gonzalez, Mr. Pritesh Narayan, Prof Rodney W. Walker, *Australian Research Centre for Aerospace Automation (ARCAA)* and Mr. Les Zeller, *Department of Employment, Economic Development and Innovation*

This project describes the potential of using an unmanned aerial vehicle, fitted with a spore trap, to detect and monitor spores of plant pathogens. We developed a sampling system that will have the ability to spatially monitor fungal spores, and protocols to interpret their spatial distribution. This tool will greatly enhance the ability to detect new incursions of fungal pathogens and to enable more accurate delimiting of distribution.

The technology will allow for earlier detection of EPP incursions in difficult areas and provide efficient and effective airborne surveillance. Further research will be conducted to refine the flying spore trap for use by surveillance staff employed in state and federal agencies.

Existing spore sampling devices are stationary at the sampling location. Location is important due to prevailing climatic conditions, and use of sampling devices in remote locations and where topography is severe is almost impossible. Where the disease is in the canopy of trees, using existing spore sampling technologies is almost impossible. Thus a new solution is desired which capability present to take spore samples in multiple locations and in regions where the topography is difficult to navigate.

The design and testing of this device is a complex multidisciplinary task involving different disciplines, aerodynamics, structural biological sampling, flight control, and avionics. The full paper will describe the design of the device as well as results of wind tunnel and flight tests.

Biography: Dr Gonzalez has a PD in Aeronautical Engineering from The University of Sydney. He is a lecturer at Queensland University of Technology and one of the lead researchers at the Australian Research Centre for aerospace Automation (ARCAA). He has developed 3 operational UAS and has published over 20 journal and refereed conference on the topic of Unmanned Aerial Systems.

Trends in biosecurity risk analysis

Mark Burgman, *ACERA*

Most countries employ qualitative methods to assess biosecurity risks. Exceptions occur in some high-profile and contentious cases, or in situations in which there are abundant data. The prevailing philosophy is that if direct data are unavailable to fully parameterize a quantitative model, then the development of such models is unjustified.

A few attempts have been made at developing quantitative models, notably, some recent import risk assessments by Biosecurity Australia. Other structured approaches, such as the British EPPO scheme, the method for assessing weed risks adopted by the Federal Australian government, and the USDA protocol, supplement qualitative assessment with rules, guidelines and point scoring systems.

The perspectives embodied in international biosecurity risk analyses assume that uncertainties in explicit (quantitative) models should be characterized by statistical distributions. Analysts are appropriately skeptical of methods that presume more than is known about the entry, establishment and spread of pests and diseases. Avoidance of traditional quantitative analysis has benefits (tractability, accessibility) and costs (loss of transparency and the submergence of otherwise explicit assumptions beneath unassailable expert judgment).

It is incorrect to characterize models as either strictly quantitative or qualitative. There is a continuum between the extremes. Alternative forms of semi-quantitative and qualitative uncertainty and risk analysis provide a host of alternatives that may be adapted to particular problems, providing a more comprehensive and explicit treatment of uncertainty, and which may result in more transparent and better decisions. I will outline some alternatives that may be useful in biosecurity risk assessments.

Biography: Mark Burgman is Director of ACERA and Adrienne Clarke Chair of Botany at the University of Melbourne. He studied at the University of New South Wales, Macquarie University and the State University of New York at Stony Brook. He worked as a consultant ecologist in Australia, the USA and Switzerland before joining the University of Melbourne in 1990. He works on risk analysis methods, ecological modeling and biosecurity risk assessment.

High-risk environmental 'solutions' involving invasive species

Tim Low and Carol Booth, *Invasive Species Council*

Solutions proposed for environmental problems can sometimes be worse for the environment than the problem they address – particularly when invasive species are involved. We present three Australian case studies that demonstrate this propensity: (1) weeds as biofuel crops promoted as climate change solutions, (2) invasive perennial pasture plants promoted as salinity solutions and (3) recreational hunting promoted as a feral animal solution.

In the case of weeds for biofuels, proponents initially ignored weed risks in their hype for invasive species such as Jatropha (*Jatropha curcas*) and Giant Reed (*Arundo donax*). Large scale plantings of

jatropha have been promoted for northern Australia. While there is now some recognition of weed risk, the proposed approach for Giant Reed in South Australian trials is voluntary management guidelines.

In the case of perennial pasture plants for salinity mitigation, the planting of very serious environmental weeds such as Tall Wheat Grass (*Lophopyrum ponticum*) has been promoted and subsidized as part of government-funded salinity programs. A Victorian Government assessment found that Tall Wheat Grass could invade over 10.4 million ha and its invasion of saltmarshes should be listed as a threatening process, but recommended against declaration as a noxious weed. The department that developed and released the most common cultivar of Tall Wheat Grass is also the department that manages weed declarations.

In the case of recreational hunting, the NSW and Victorian Governments are funding ad hoc hunting for feral animal control. But this breaches government standards for feral animal control which specify that ad hoc hunting is ineffective. Worse, the programs limit effective control – particularly of feral deer that are managed as a hunting resource – and increase the risks that feral animals will be shifted to increase hunting opportunities, as happens particularly with deer and pigs.

The case studies highlight institutional failings, such as conflicts of interest and the failure to routinely assess invasive species risks.

Biography: Tim Low is a biologist and author. He wrote Feral Future: the Untold Story of Australia's Exotic Invaders published by Penguin.

Modeling biosecurity risks: more complexity or back to basics?

David Jordan, *New South Wales Department of Primary Industries*

Economic and health risks arising from developments in international trade, the popularity of international travel and the emergence of potent new pathogens are reasons why decisions about biosecurity are being subjected to greater scrutiny. Central to improved decision making in biosecurity is finding better ways for assimilating information from a broad variety of sources. Obstacles in this process include traditional disconnects between disciplines or institutions due to a lack of common understanding, lack of a common vocabulary, or simply a lack of opportunity for interaction. Modeling the movement of contagions and the impacts of decisions is ideally suited to overcoming these barriers. When carefully targeted, modeling can deliver a better basis for decisions because it provides a platform for merger of discipline-specific and institution-specific ideas and directs them at a common goal.

Despite the appeal of models for supporting decisions in biosecurity, they have not gained uniform acceptance amongst biologists and policy makers. If models are to be more widely embraced then some changes are needed. Firstly, the process of development of models needs to begin much earlier in the research cycle, so that discipline specialists are collecting the type of information that modelers can use to build a useful representation of agent-host-disease systems. Secondly, a “purely scientific” approach to modeling should be avoided. Rather, modeling should be seen as a tool for organizing information, describing and communicating the important relationships in a complex system. Inevitably this means that more models should be less “nerd friendly” and more “biologist friendly” so addressing common misperceptions that models are the product of “smoke and mirrors”. Thirdly, model building projects should be inclusive of multiple disciplines with this facilitated by more attention in undergraduate and post-graduate education to equip scientists with the skills needed for inter-disciplinary collaboration. In this presentation, these and other aspects of the application of models to biosecurity management will be explored.

Biography: David Jordan is a doctoral-qualified epidemiologist and veterinarian with a strong focus on evidence-based decision making in biosecurity. He has practical roots in disease diagnosis, field research and disease eradication across many sectors of the Australian livestock industries. For the last 15 years he has worked intensively on decision support particularly in regard to food-safety, antimicrobial resistance and zoonotic infections. David has been appointed to many expert groups advising national and international bodies on public health aspects of food-borne disease and zoonotic infections. He has actively participated in post-graduate teaching at various Australian universities.

Improving the quality of qualitative risk assessments

Mark Burgman, *ACERA*

Qualitative risk assessments use a variety of subjective and 'semi-quantitative' approaches, supplemented occasionally by quantitative analysis. New tools have emerged that capture expert judgement about system functions and the values of variables more reliably. These tools may be used together with prescriptions for combining and propagating uncertainty through chains of reasoning to provide a more transparent and repeatable qualitative estimate of risk.

Biography: Mark Burgman is Director of ACERA and Adrienne Clarke Chair of Botany at the University of Melbourne. He studied at the University of New South Wales, Macquarie University and the State University of New York at Stony Brook. He worked as a consultant ecologist in Australia, the USA and Switzerland before joining the University of Melbourne in 1990. He works on risk analysis methods, ecological modeling and biosecurity risk assessment.

Reconciling quantitative and qualitative approaches to import risk assessment

Simon Barry, Keith Hayes and Petra Kuhnert, *CSIRO Mathematical and Information Sciences*

There are a number of international standards and guidelines for import risk analysis. The International Plant Protection Convention (IPPC) produces guidelines for assessing plant products and the World Organisation for Animal Health (OIE) for animal products. These guidelines do not specify the exact detail of any assessment but rather provide high level guidance about the structure and requirements of any analysis.

Qualitative risk assessments have a significant history in import risk assessment. While there is widespread belief in the biosecurity policy arena that qualitative risk assessments are appropriate for many decision making processes, debate still exists about the scientific quality (consistency, transparency and repeatability) of these assessments. In the late 1990's proposals to achieve greater transparency via more explicit quantification appeared in the scientific literature. This led to a significant literature based on the expression of uncertainty using probability distributions and analysis via Monte Carlo methods.

The application of this quantitative approach encounters significant difficulties when applied to complex trade and pest biology. In this talk we will discuss these issues. We will then provide a novel framework for linking the quantitative and qualitative approaches. This allows better framing of questions and clearly demonstrates the continuum between quantitative and qualitative approaches.

Biography: Simon Barry has a degree in Science and a PhD in Biostatistics from the Australian National University. After lecturing at ANU he joined the Bureau of Rural sciences in the Department of Agiriculture, Fisheries and Forestry where he built the Risk and Modelling group. In the department he was involved in a range of biosecurity issues such as developing the risk based decision support frameworks for the national system for managing marine pests, deveoping scoring systems for risk assessment of vertebrate animals, import risk assessment for high profile agricultural commodities, the development of efficient monitoring programs and the devopment of approaches to species distribution modelling and cost sharing. Simon is currently program leader for the Environmental Informatics program in CSIRO mathematics, informatics and statistics. This program works on a wide range of environmental monitoring and risk assessment problems.

Biologically inspired computing provides add-ons for pest risk assessment in biosecurity

Susan P. Worner, Takagoshi Ikeda, *Bio-Protection Research Centre, Lincoln University*, Gwénaël Leday, *Department of Mathematics, VU University*, Dean Paini, *Co-operative Research Centre for National Plant Biosecurity*

Biologically inspired analysis techniques and computer models in the area of artificial intelligence and machine learning are being applied in many scientific disciplines with considerable success. Using both terrestrial and freshwater examples we show how some of these approaches can support the process of

developing impact risk assessments (IRAs) or import health standards (IHS) used by national plant protection organisations. These assessments determine the risk of importing a particular product from another country. They identify the known pest species present in the exporting country and those known to be associated with that product. We show how artificial intelligence techniques can be used to rank known risks and to improve surveillance and economic impact analysis. We give examples of how these tools can indicate which species most threaten a region, where in the world they might come from, where they might establish a viable population and where they are likely to spread. We also discuss how these techniques can be used to test surveillance and eradication methods before an incursion happens. Such approaches will assist scientists and authorities to be better prepared to prevent new incursions of alien species and to slow their spread if they happen to establish.

Biography: Associate Professor Susan Worner has long experience in the ecoclimatic assessment and risk prediction of invasive species. She currently leads research on Intelligent Systems for Biosecurity for the Bio-protection Research Centre, Lincoln University that has produced innovative modelling approaches to pest risk assessment using artificial neural networks and machine learning. She has current research projects within the New Zealand B3 OBI, with the Australian CRC Plant Biosecurity, EU FP7 PRATIQUE and MAF BNZ Operational research. Prof Worner also belongs to an international group including APHIS/USDA/CSIRO/PRATIQUE scientists reviewing best practice for Pest Risk Modelling and Mapping.

Risk-return approach to biosecurity risk management: The potential role of the EpiCast Model

Don Gunasekera and David Newth, *CSIRO Centre for Complex Systems Science and CSIRO Marine and Atmospheric Research*

The absence of major agricultural pests and diseases has enabled Australian agricultural exporters to maintain favourable market access overseas. To maintain and improve our market access, we need to continually develop cost effective risk management strategies across the entire biosecurity continuum. This need is highlighted by the recent Beale Review into quarantine and biosecurity arrangements within Australia. In this presentation, we illustrate the usefulness of the EpiCast (Epidemic foreCast) framework as a decision support tool to assist the management of agricultural biosecurity risks. EpiCast is a high-resolution individual-based simulation model that takes a "whole of population" approach to modelling the spread of emerging diseases and pests. In the US and Europe, EpiCast and related models, have provided valuable input into the development of biosecurity preparedness, mitigation and recovery strategies. As a risk analysis tool, EpiCast can help policy makers, agricultural producers and importers/exporters to formulate cost effective mitigation and targeted intervention strategies associated with potential biosecurity threats. In this regard, we demonstrate the usefulness of the EpiCast model in examining pest/disease spread/transmission dynamics and impacts. Scenario analysis using the EpiCast framework can provide the foundation for the development and assessment of risk management options (such as control, containment and eradication). We also highlight the potential applicability of the model to help manage biosecurity risks using a 'risk-return' approach. This involves focussing our biosecurity efforts on those areas that will provide the greatest reduction to potential threats —be it disease or pest; natural or human induced— in a cost effective manner.

Biography: Don Gunasekera is a Visiting Scientist at the CSIRO Centre for Complex Systems Science. Previously he was the Chief Economist at ABARE. He has an ANU PhD. in Economics and has completed Harvard University Senior Managers in Government Program. Don has worked on the socio-economic impacts of influenza and integrated assessment modelling.

David Newth is a Research Scientist at the CSIRO Centre for Complex Systems Science. He was the first PhD graduate in complex systems from Charles Sturt University and went on to win the Vice Chancellor's award for research excellence. In 2008, he was awarded the CSIRO's John Philip Science Medal. His research interests include: complex systems, integrated assessment modelling, agent based modelling, network analysis and human behaviour.

Pest risk prioritization using Deliberative Multi-criteria Evaluation (DMCE): a case study

Michael V. Hurley, Kim E. Lowell, *Department of Primary Industries – Victoria and Cooperative Research Centre for National Plant Biosecurity*, David C. Cook, *CSIRO Entomology*, *Cooperative Research Centre for National Plant Biosecurity and The Australian National University, Fenner School for Environment and Society*, Shuang Liu, *CSIRO Entomology and Cooperative Research Centre for National Plant Biosecurity,* Abu-Baker M. Siddique, *Department of Agriculture and Food - Western Australia and Cooperative Research Centre for National Plant Biosecurity* and Art Diggle, *Department of Agriculture and Food - Western Australia*

The extent and range of biophysical, economic, and social data and associated uncertainty can confound policy-makers and stakeholders who are trying to make sense of a natural resource-related issue. We structured participatory engagement in order to work toward achieving the best possible policy decision in the face of obstacles such as complex, uncertain, and conflicting information. We used Deliberative Multi-criteria Analysis (DMCE) methodology to guide a workshop to prioritize the risk of Emergency Plant Pests (EPPs). DMCE was used to bridge the gap between science and policy communication by structuring participant judgments in a framework that guided decision-making. To aid stakeholders in the prioritization of biosecurity risk investment options, we provided information on invasive pest risk including a bio-economic pest impact model, socio-economic activity and ecological impacts. In addition, the type and number of participants can impact how the decision is carried out. The task was one of selecting stakeholder group participants in a manner that was fair, transparent, representative, and effective in terms of the decision issue at hand. We assessed whether stakeholder analysis methodology was effective in terms of interactions, the deliberation which transpired and the decision reached among members of the final group selected. The DMCE methodology used in the workshop delivered a high level of consensus between participants within the first two rounds of weighting criteria importance, and this was not derailed by the introduction of uncertainty late in the process. We present results of our DMCE case study workshop, the choice of stakeholders, the effect of group deliberation, and the impact that revealing uncertain information had on EPP risk results.

Biography: Michael Hurley is a scientist with the Department of Primary Industries, Victoria. He has worked in the field of ecology and environmental planning for the past 5 years. He is currently a member of an Enhanced Risk Analysis Tools project with the Cooperative Research Centre for National Plant Biosecurity, and partners Plant Health Australia, Horticulture Australia Limited, and the Rural Industries Research and Development Corporation.

Hierarchical Bayesian models: epidemiology and data for delimiting invasions

Mark Stanaway, Robert Reeves and Kerrie Mengersen, *Cooperative Research Centre for National Plant Biosecurity and Queensland University of Technology*

Hierarchical Bayesian models provide a cohesive statistical framework for integrating information from surveillance data and epidemiological knowledge. Current informal approaches to delimiting incursion extent rely on expert ecological or epidemiological interpretation of presence / absence data over space and time. Bayesian models offer a rigorous statistical treatment of this approach by hierarchically decomposing the problem into simple component models. For example, an observation model can account for the surveillance data, conditional on the hidden extent of the incursion and uncertainty in detection parameters. The hidden extent of the incursion can be defined by a dynamic invasion process model that includes uncertainty in epidemiological parameters. These statistical models can be combined and the probable extent of the incursion over time can be estimated using Markov chain Monte Carlo techniques.

Models can assist decision-making across a range of plant biosecurity surveillance activities including early detection, market access and incursion response. Risk maps can be incorporated into GIS systems and updated as new data arrive to help biosecurity regulators assess program performance and redirect surveillance to address current risks.

Biography: Mark Stanaway is a Data Analyst with Biosecurity Queensland and a PhD student, supported by the Cooperative Research Centre for National Plant Biosecurity at the School of Mathematical Sciences, Queensland University of Technology.

Robert Reeves is a lecturer at the School of Mathematical Sciences, Queensland University of Technology.

Kerrie Mengersen is a statistician with expertise in fundamental statistical research, applied statistics and statistical consulting. She is Professor of Statistics in the School of Mathematical Sciences and Director of the Collaborative Centre for Data Analysis, Modelling and Computation at Queensland University of Technology, Brisbane, Australia.

Ecological simplification is bad for one('s) health: an Australian perspective

Ro McFarlane, *Australian Biosecurity Cooperative Research Centre and National Centre for Epidemiology and Population Health, A.N.U.*

Humans are creating landscapes that favour generalist species and it is these (particularly those that tolerate or do well in human modified environments) that dominate emerging infectious diseases (EIDs) of wildlife origin. Being a generalist with a broad host range is also a key feature of pathogens responsible for these diseases. EIDs from wildlife are reported to be increasing in the face of rapidly declining biodiversity. While mammal species diversity has been reported to be a predictor of zoonotic EID emergence, it is not mammal diversity *per se* that represents the risk. Human activities through land use drive many of the processes leading to emergence. What can be said, currently, to guide land use to minimize opportunities for emergence in Australia?

Australia's mammal biodiversity is greatest on the east coast of Australia where human population is also greatest and is continuing to expand. Accompanying us are our companion animals, pest species, intensively-managed livestock, horticulture and the ever expanding "urban (and periurban) forest". Here, an environment with stable food and shelter resources is replacing the capricious existence in the bush for wildlife species that can exploit human-modified habitats. The emergence of Hendra, Menangle and Australian Bat Lyssa virus and the spread of some other zoonotic diseases are examined in this context. Whilst we are often advised to look north and offshore for the next big thing, we need to be mindful of the habitats and the multispecies communities we are creating.

This paper explores the potential to add zoonotic disease prevention to the competing land use agendas, and the opportunities to engage with national and international conservation objectives as another step towards operating in a One Health framework.

Biography: Ro McFarlane graduated with a BVSc from Sydney University in 1989 and a M. Ecosyst Mgt from U.N.E. in 2005. She worked in rural and zoological veterinary practice for 10 years then in human impacts and wildlife health research, community conservation and the development of Indigenous Protected Areas. She is currently enrolled in an Australian Biosecurity CRC sponsored PhD looking at patterns of emerging infectious diseases in the Australasian region, focusing on human-animal interactions and habitat disruption.

Testing a self organising map in a virtual world of invasive species

Dean Paini, *CRC - National Plant Biosecurity and CSIRO, Entomology* and Felix Bianchi, *CSIRO, Entomology*

Identifying species that have the highest likelihood of invading a particular region presents a formidable challenge to researchers and biosecurity agencies. A self organising map (SOM) is a type of machine learning or artificial neural network which has recently been successfully used for this purpose. A SOM takes worldwide species distributions and, based on species associations, ranks species in terms likelihood of establishing in a particular region. This methodology has the advantage of being able to process thousands of species simultaneously and to make predictions for any region of the world. However, the question that remains is how accurate are these predictions because they cannot be tested empirically. We therefore deployed a simulation approach by creating a virtual world which was populated randomly with invasive species in a fraction of the regions (initial distribution) in which they were able to invade (final distribution). We then tested how well SOM predicted species' final distributions based on the initial distributions. When species were initially present in only 10% of their final distribution, the SOM on average correctly ranked 76% of the species in a region.

Considering species in this virtual world had extremely restricted initial distributions, and significantly more restricted than real world wide distributional data, this tool shows excellent potential for predicting new invasions at a world-wide scale.

Biography: Dean Paini completed a BSc. (Hons) at University College Dublin, Ireland in 1997. He then completed a PhD at the University of Western Australia investigating the impact of the honey bee on Australian native bees. From there he moved to Florida to take up a postdoctoral associate position at the University of Florida where he researched thrips ecology. His current position as a postdoctoral fellow is with the CRC-National Plant Biosecurity and he is located in the Entomology Division of CSIRO. It is in this position that he has been using artificial neural networks to predict species invasions.

Comparative assessment of the biosecurity risks associated with small and large scale pig producers

Jenny-Ann Toribio, Marta Hernandez-Jover, Nicole Schembri, *University of Sydney*, Trish Holyoake, *NSW Department of Primary Industries* and Tony Martin, *Department of Agriculture and Food Western Australia*

Practices of small-scale pig producers are believed to pose a higher risk of introduction and spread of exotic diseases than those of larger producers. Previous research (Australian Biosecurity CRC project 3.016RE) in Australia, suggested that small-scale pig producers had few on-farm biosecurity practices, poor disease knowledge and understanding of swill feeding, and limited veterinary contact. This study is a comparative assessment of the risk of introduction and spread of foot and mouth disease (FMD) through small and large scale pig producers. The aim of the study is to quantify the nature and magnitude of the biosecurity risks posed by each sector of the industry.

The risk assessments follow the OIE methodology for risk analysis, assuming that FMD has arrived in Australia and the exposure and consequences are assessed. Input data is based on the ABCRC 3.016RE project and data on producers' practices collated during 12 case study interviews, postal surveys and expert judgments. The postal survey was distributed among pig producers with less than100 sows registered at the Cumberland Livestock Health and Pest Authorities crown brand register, the Australian Pig Breeders Association members and participants of Australian Pork Limited road shows. Small-scale pig producers were separated into those selling through commercial pathways (saleyards and abattoirs) and those selling through informal means (private sales) as their practices were believed to differ.

A scenario tree with the pathways of exposure and spread of FMD for each sector of the pig industry has been drawn and the likelihood of each pathway calculated. Consequences for each scenario outbreak are currently being evaluated. This paper presents results of the assessments, providing information on whether the biosecurity risks, given the presence of small-scale pig producers, are greater than that in their absence. This information will support decisions regarding small-scale producers' extension needs and management of animal biosecurity.

Biography: After finishing the Veterinary Degree, Marta conducted a PhD on swine traceability at the University Autònoma of Barcelona (Spain). Marta moved to Australia as the researcher responsible for a company which specialised in livestock electronic identification. In September 2006, Marta joined the Farm Animal and Veterinary Public Health group at The University of Sydney as a postdoctoral researcher, working on an ABCRC project on biosecurity among small-holding pig producers. In October 2007, Marta was appointed as the ABCRC Epidemiology Research Fellow. Since then, she has been working on public health, epidemiology and risk analysis.

Developing a paradigm for integrated insect eradication in orchard, urban and peri-urban areas

Bill Woods, *Department of Agriculture and Food Western Australia*, Max Suckling, *Plant and Food Research New Zealand*, Dave Williams, *Department of Primary Industries Victoria* and Greg Baker, *South Australian Research and Development Institute*

Eradication of pest incursions and maintaining area freedom from key pests has become more important when the mere presence of the pest and the use of pesticides for its control may impact

negatively on market access. Eradication will only be feasible if it is economically, environmentally and sociologically sustainable especially if the incursion occurs in urban areas or the surrounding peri-urban zone where farming, hobby farms, recreation, and housing all coalesce.

Eradications in the past have often been characterized by a government knows best approach using broad-spectrum and often destructive technologies. In the internet age this is not a sustainable model. New technologies need to be developed that will effectively eradicate incursions but with few perceived side effects. Compatible technologies such as the sterile insect technique, mating disruption, attract & kill, mobile mating disruption, biological insecticides and biological control need to be combined in a robust system that can be modified to deal with different pest incursions. These systems need to be developed ahead of time and sold to all stakeholders so that when an incursion occurs the eradication plan can be adopted without delay.

The invasive native Australian leafroller Light brown apple moth (LBAM) (Epiphyas *postvittana*)(Lepidoptera: Tortricidae) is being used as a model species to develop such an eradication paradigm. Many exotic Tortricids are key pests overseas and LBAM itself is subject to an eradication/containment program in California. The eradication biology of the species has been studied as part of a completed CRCNPB project. Mating disruption is well developed and new technologies such as sprayable pheromone are becoming available as a result of the eradication effort in California. Further trials are being carried out in urban & peri-urban areas in Western Australia and vineyards in South Australia to combine technologies in a holistic approach to pest eradication. Results to date will be discussed as will the potential for adopting the LBAM paradigm to other moths or insect orders.

Biography: Bill Woods is a Senior Entomologist with the Department of Agriculture & Food Western Australia (DAFWA) at South Perth. His research focus is on developing sustainable techniques to manage or eradicate key horticultural pests and in use of the sterile insect technique. Bill has worked as an applied entomologist since 1974 on pests of cotton, broadacre crops and horticulture and has been involved in eradication programmes programs against codling moth and fruit flies.

Community engagement in biosecurity – success in six horticultural case studies

Heleen Kruger, *Bureau of Rural Sciences* and Anna Carr, *Department of Agriculture, Fisheries and Forestry*

There is widespread recognition of the need to engage local communities and landholders – including farmers, peri-urban and urban residents, farm workers and travellers – in producing good biosecurity outcomes.

Simultaneously, there are many biosecurity engagement activities occurring in horticultural regions throughout Australia. However, there is a lack of knowledge about what helps or hinders effective whole-of-community biosecurity engagement in different contexts. There are also opportunities for more national collaboration and strategic coordination between engagement projects to foster mutual learning and ensure efficient use of resources.

The Engaging in Biosecurity in Horticultural Regions project conducted by the Bureau of Rural Sciences' Social Science and Policy Unit aims to develop a biosecurity engagement framework comprising landholders, industry and local communities for the early detection and reporting of pest and disease incursions. The objectives of the three-year project include:

- identifying the principles and practices that contribute to successful biosecurity engagement
- providing guidelines for biosecurity engagement investments
- strengthening collaboration between biosecurity engagement practitioners.

This presentation addresses the first objective listed here. It profiles the principles and practices underlying biosecurity engagement initiatives in six horticultural case studies in regions across Australia. These profiles extend knowledge of, and aggregate lessons about, successful engagement tools in different contexts.

Qualitative research methods based on stakeholder interviews and focus groups were analysed using NVivo software. Findings demonstrate the importance of factors such as the culture of horticultural agencies, social networks, departmental coordination between communications and operational staff,

the duration of engagement, the presence of champions, biosecurity risk perceptions, personalities and attitudes and the influence of past experiences on present practices.

Biography: Heleen Kruger is a social scientist in the Social Sciences and Policy (SSP) section of the Integrated Research Branch, ABARE - BRS, Australian Department of Agriculture Fisheries and Forestry. SSP provides policy and research expertise relating to rural industries, people and communities in Australia.

Heleen has masters degrees in rural development from the Univesity of Ghent, Belguim and the University of Pretoria, South Africa. She has worked five years in the Australian pork industry overseeing the industry's on-farm quality assurance program. This role involved significant stakeholder engagement.

Poster Display Listing and Abstracts

(in alphabetical order)

Poster Display Listing

Poster #	Title	Presenting Author
1	Wheat stripe rust infecting barley grass: evolutionary pathways and potential threats	Jordan Bailey
2	Evaluation of model selection procedures in DNA barcoding	Laura Boykin
3	Establishment of a national reference laboratory for *Trogoderma* diagnostics	Oonagh Byrne
4	Genetic Diversity of Australian *Bacillus anthracis* isolates	Mark Fegan
5	Plant Health Experience Register (PHER)	James Garden
6	Development of biosecure packaging for transport of emergency plant pest samples	Barbara Hall
7	Towards a coordinated national diagnostic system in Australia	Barbara Hall
8	Estimating the diagnostic accuracy of tests used in emergency plant pathogen surveillance	Nichole Hammond
9	Simulating fire blight spread and establishment in Australia	Colin Hanbury
10	Vectoring of avian influenza antigens using a recombinant avian herpes virus vector	Risza Hartawan
11	Multiplex molecular detection of avian viral pathogens	Hans Heine
12	Revision of the genus *Epiphyas* – the light brown apple moth in context	Bobbie Hitchcock
13	Enhancing New Zealand's cattle identification and tracing systems: lessons from other systems worldwide	Christopher Houston
14	Identification of effectors in *Venturia inaequalis*	Daniel Jones
15	Optically encoded particle-based assays for high throughput biosecurity screening applications	Lie Kuo Liem
16	Farm Biosecurity – a one stop shop for better practice	Jim McGrath
17	Footwear as a biosecurity threat: defining the hazards and possible solutions	Mark McNeill
18	Molecular phylogeny of some important plant pathogenic smut fungi	Alistair McTaggart
19	Pospiviroids in the West Australian sub-tropics: phylogeny, incidence and new hosts	Alison Mackie
20	Resistance monitoring and protocol development: key components in ensuring the biosecurity of post-harvest grain	Manoj Nayak

21	Validating feathers for the field diagnosis of highly pathogenic avian influenza subtype H5N1	Harimurti Nuradji
22	Post harvest grain storage – from farmer to market	YongLin Ren
23	Individual–based modelling of the evolution and spread of resistance to pesticides in stored grain insect pests	Mingren Shi
24	Biosecurity – so simple it could make me cry! The use of analogies in understanding biosecurity concepts	Abu-baker Siddique
25	The suppression and transmission of Phytophthora disease is assisted by fungicide application to plants	Amy Smith
26	When crops and climate collide: biosecurity threats associated with stabilizing rice production in Australia	Mark Stevens
27	Invasive diseases of cucurbits in Taiwan	Jiunn-Feng Su
28	CropSafe®, protecting Victoria's grain industry through passive surveillance	John Taylor
29	BSES biosecurity: safeguarding the sweetest industry	Nicole Thompson
30	Recent incursions of plant pathogens in the Northern Territory Australia	Lucy Tran-Nguyen
31	Characterisation and multiplexed detection of endemic and exotic begomovirus species in Australia	Sharon Van Brunschot
32	Development of a multiplexed immunoassay for the detection of banana viruses	Jenny Vo
33	Improved delivery of extension messages through monitoring practice change during grape phylloxera area freedom re-zoning processes	John Whiting
34	Need organisms identified for biosecurity? Try DNA melting analysis	Louise Winder
35	Invasion genetics of Russian Wheat Aphid: preliminary data from Western China	Bo Zhang

Wheat stripe rust infecting barley grass: evolutionary pathways and potential threats

Jordan Bailey, *Plant Breeding Institute, University of Sydney*, Dr. Colin Wellings and Prof. Robert Park

Wheat stripe rust is caused by the fungal pathogen *Puccinia striiformis f. sp. tritici* (Pst). Although predominantly infecting wheat, with yield losses of up to 60%, it is also known to infect barley, rye and triticale. Wheat stripe rust is recognised as comprising a range of pathotypes, which are separated according to the unique combination of avirulence/virulence characteristics. These pathotypes are currently identified by observing the disease phenotype on a wheat differential set that contains defining host genotypes. Wheat stripe rust has been observed infecting Australian barley grass populations by ongoing rust surveys, conducted at the University of Sydney's Plant Breeding Institute. At first, infection levels on barley grass were low but have increased over the years, suggesting a shift towards virulence for barley grass.

Barley grass has the potential to further differentiate Pst pathotypes whereby isolates that are determined to be the same pathotype when using the wheat differential set may be differentiated by a barley grass set. This was observed in isolates of the original 1979 foreign incursion collected in 1982 and 1984, which were identified as the same pathotype when using the wheat differential but with contrasting responses when cultured on barley grass clones.

To further test this hypothesis, a barley grass differential set has been developed from accessions already present in a collection at the University of Sydney's, Plant Breeding Institute. Barley Grass accessions were tested using the 1982 and the 1984 isolates. A number of barley grass populations were resistant when inoculated with the 1982 isolate but had a low or moderate infection level when inoculated with the 1984 isolate. A selection of these barley grass clones were included in a barley grass differential set to further test recent isolates of wheat stripe rust.

One of the main concerns driving this research is the possibility of wheat stripe rust developing virulence for cultivated barley. We may be witnessing the evolutionary pathway that led to the rise of Barley Stripe Rust, a pathogen not currently present in Australia but one that has caused severe damage elsewhere.

Biography: Jordan Bailey graduated from the University of Sydney with a degree in Agricultural Science. She began her PhD in July 2009 and is working on the wheat stripe rust pathogen *Puccinia striiformis f. sp. tritici*, at the University of Sydney, Plant Breeding Institute. Majoring in agricultural genetics, she has an interest in plant genetics and plant pathology. Taking part in the Sydney Royal Botanic Gardens internship program in 2007 has also given her an interest in plant taxonomy and systematics. Jordan is happy that this project gives her the opportunity to work in all these areas.

Evaluation of model selection procedures in DNA barcoding

Laura Boykin, *Bio – Protection Research Centre,* Rupert Collins and Karen Armstrong

DNA barcoding is playing an important role in identifying invasive species worldwide. Ensuring that the most appropriate method for data analysis is used is of vital importance to correctly assign an unknown (possible invader) to a identified reference specimen. The standard model of molecular evolution used in DNA barcode analyses is Kimura's two-parameter model (K2P). This model assumes the occurrence of equal base frequencies, and transitions/tranversions at different rates. However, the assumption of base frequencies being identical (A=25%, T=25%, G=25%, C=25%) is unrealistic in most datasets. Therefore, in barcoding where species identification is based on relative percent similarity, and base frequency differences are not taken into account, assignment of an unknown to species may be affected. The goal of this study is to determine if percent similarity and/or tree topology are altered by using the best fitting model (determined by jModelTest) compared to the standard barcoding model (K2P). Using different data sets from economically important exotic insect species, including fall web worm (*Hyphantria cunea*), pink gypsy moth (*Lymantria mathura)*, yellow peach moth (*Conogethes punctiferalis*, fruit flies (Tephritidae), and high risk ornamental fishes (*Danio* and *Puntius*), preliminary results show that model selection does not significantly affect tree topology. However, it can affect estimations of percent similarity in certain situations, and therefore perception about how a species clade is delimited. A potential solution may be a two step process, using firstly the complete reference

DNA barcode dataset for identification under the K2P model (for identification to a species clade), followed by determination of the optimal model for focal sister taxa, thereby providing greater confidence in branch length estimations.

Biography: Laura is a postdoctoral fellow at the Bio-Protection Research Centre in Lincoln, New Zealand. She is interested in molecular phylogenetic analyses and invasive species. Her primary research involves utilizing DNA sequence data to answer questions regarding species delimitation and invasibility of quarantine pests, for both risk assessment and diagnostic purposes. Taxon interests include *Bemisia tabaci* and *Diaphorina citri* plus a number of tephritids and *Lymantria* species.

Establishment of a national reference laboratory for *Trogoderma* diagnostics

Oonagh Byrne, Andras Szito, Pia Scanlon, Mike Grimm *Department of Agriculture and Food Western Australia* and Mark Castalanelli, *Curtin University of Technology*

The Khapra beetle, *Trogoderma granarium* Everts (Coleoptera: Dermestidae) is recognised as the most serious stored product pest in international trade, and is the subject of strict quarantine measures in many countries. It has been categorised by Plant Health Australia (PHA) as one of the top 5 biosecurity threats to the Australian Grains Industry. A diagnostic reference laboratory with expertise in morphological and molecular diagnostics will have the capacity to diagnose suspect specimens of *Trogoderma* species detected in quarantine and biosecurity surveillance reliably.

There are 52 described Australian *Trogoderma* species, any of which can find their way into grain stores. Their discovery in grain shipments and their very likely misidentification as exotic pest species has the potential to seriously compromise Australian grain exports. Diagnostically the Khapra beetle can only be reliably identified by a limited number of highly skilled taxonomists trained in the morphological methods needed to identify these species. It will be necessary to obtain validated specimens from a biogeographically diverse range of countries where it does occur, and conduct a National Trapping Program, in order to reliably differentiate *T. granarium* from other related Dermestids known to occur in Australia. Type material from overseas and Australian collections will be keyed out using existing keys. Molecular diagnostic tests will be developed using validated samples. The project's diagnostic imaging lab will be used to photograph validated specimens, including 3-D detailing of morphological characters.

The laboratory will provide molecular and morphological diagnostic services and training, and provide a resource for other biosecurity projects, potentially providing methods specific to surveillance and contingency plans, in the event of incursion of pest *Trogoderma*. Establishment of an accredited facility addresses the "International importance of accredited diagnostic laboratories using accepted diagnostic procedures" as written in the International Standards for Phytosanitary Measures (ISPM 27).

Biography: Oonagh Byrne, BSc (Zoology), MSc (Biotechnology), PhD (Agriculture). Dr Byrne's current research is on the establishment of a National Reference Laboratory for *Trogoderma* and related Dermestidae (CRCNPB20137) at the Department of Agriculture and Food WA. Prior to taking up the position at DAFWA, Dr Byrne played a key role in transferring pea weevil resistance into Australian field pea cultivars, developing a molecular marker protocol for field pea resistance screening, and in publishing on the genetics of pea weevil resistance in field pea (GRDC, ARC). Dr Byrne holds an adjunct Research Fellow position at UWA.

Genetic Diversity of Australian *Bacillus anthracis* isolates

Mark Fegan, Janine D Muller, Ilhan M Mohammad, Simone Warner and Catherine Ainsworth, *The Department of Primary Industries*

Anthrax, caused by *Bacillus anthracis*, is an emergency animal disease in Australia. The disease causes livestock mortalities, has zoonotic potential and can impact on the international trade of livestock and their products. Outbreaks of the disease can occur when animals come into contact with spores surviving in soil. These outbreaks are largely confined to Victoria and New South Wales, and occurrence of anthrax in other parts of Australia is rare. In Victoria anthrax is mainly a disease of

cattle and occurs primarily in the Goulburn Valley. In New South Wales anthrax occurs in a recognised belt across the centre of the state, and predominantly affects sheep. Although the regions where anthrax is endemic in Victoria and New South Wales are well documented, sporadic occurrences outside of these areas do occur.

Molecular typing of bacterial pathogens has been employed as an epidemiological tool for many years. However, the genome of *B. anthracis* is highly monomorphic which makes differentiation of strains difficult, and to date, no comprehensive molecular typing study of Australian *B. anthracis* strains has been published. Multiple locus variable-number tandem repeat analysis (MLVA) is currently the most discriminatory method for assessment of genetic diversity of *B. anthracis*.

The discriminatory power of MLVA, based on the examination of 25-loci, was employed to assess the genetic diversity of a set of temporally and geographically separated Australian *B. anthracis* isolates from various hosts and environmental samples. This molecular typing method has improved our knowledge of the diversity and evolution of *B. anthracis* in Australia. By employing molecular typing techniques to Australian *B. anthracis* isolates from disease outbreaks over the last thirty years further insights into the epidemiology of the pathogen in the Australian environment have been obtained.

Biography: Mark Fegan has worked in the area of molecular diversity and molecular diagnostic test development for the last 15 years. His work has primarily centred on the study of exotic and endemic pathogens of biosecurity interest to Australia. He is presently working at the Department of Primary Industries in Victoria where, amongst other pathogens, he works on *B. anthracis* as a member of the National Anthrax Reference Laboratory.

Plant Health Experience Register (PHER)

James Garden, *Plant Health Australia*

PHER is a tool to aid communication and collaboration within the plant health community, and to help improve response times in the event of an exotic plant pest incursion. The secure database contains information on professionals with plant health experience, including their specific crop or pest expertise and experience, qualifications and contact details.

The database currently contains more than 240 experienced plant health specialists, including entomologists, pathologists and crop specialists from Australia. Over the past year PHER has undergone a number of enhancements aimed at making it more effective. These include improvements to the search functionality, the way in which experience criteria is recorded and managed, and the look and feel of the database. In addition, the search function has now been opened up to all registered users, enabling users to network on professional projects. This increased functionality has seen a growth in user registrations, creating a larger “pool of talent” from which to source credible experts at short notice to manage the impact of an emergency plant pest incursion better.

Biography: James Garden commenced work at PHA as a Project Officer in November 2006. He obtained degrees in Science and Commerce from the University of Otago before moving from New Zealand to Canberra in 2006. Since beginning at PHA, James has worked in the National Strategies and Policy Coordination business area as well as administering several information databases of relevance to plant health.

Development of biosecure packaging for transport of emergency plant pest samples

Barbara Hall, *South Australia Research and Development Institute,* P Glocke and A McKay

There are significant risks involved with movement of diagnostic samples potentially containing Emergency Plant Pests (EPP), within Australia and internationally. This has recently been recognised by the proposed changes to the UN regulations for transport of dangerous goods, which will include for the first time quarantine plant pathogens in the definition of infectious agents. In addition, an Australian biosecurity review highlighted the difficulties with packaging and transport of test samples between states as an issue that must be resolved to ensure the development of a successful national

diagnostic system for EPP within Australia. A recent project funded by the Cooperative Research Centre for National Plant Biosecurity (CRCNPB) aims to address these issues by developing packaging standards that can be used for the secure and legal containment and transport of these samples for diagnosis. Specifications are being developed for suitable packaging standards to comply with UN regulations for the transport of plant, soil and insect samples that will maintain integrity during transport, be readily available to all users, and meet all legal requirements. In addition, the project aims to help raise awareness on the importance of correctly packaging possible or confirmed EPP's for transport. This paper outlines the evaluation process being undertaken to develop the specifications, aimed at using suitable, readily available and accessible packaging.

Towards a coordinated national diagnostic system in Australia

Barbara Hall, *South Australian Research and Development Institute*

The accurate and rapid diagnosis of plant pests and diseases underpins all response activities aimed at preventing the establishment of exotic pests, managing endemic plant pests, and is a critical component of surveillance activities. In Australia, diagnostic services are delivered by a range of agencies dispersed across a diverse geographic and climatic range. The majority of diagnostic services are provided by Government agencies of the six state and two territory agencies. Some are also delivered by the Australian Government, commercial diagnostic laboratories, CSIRO, and the universities. Diagnostic operations are often performed in conjunction with collaborative research activities, with services provided on an *ad-hoc*, commercial or nationally coordinated basis as required. Diagnostic activity is often not centrally coordinated within the states and territories, and details are not easily accessed due to a lack of readily searchable databases. Therefore agencies can have difficulty in establishing their plant health status with any degree of certainty. In addition, there has been an increasing level of activity and importance of diagnostic activity nationally. Between January 2006 and May 2009, 45 new pest or diseases have been brought to the attention of the Office of the Chief Plant Protection Officer (OCPPO) and have warranted action by the Consultative Committee on Emergency Plant Pests. There has been an increase in investigations into suspected new pests and diseases, with the numbers of investigations conducted by one state agency increased from 16 in 2006 to 64 in 2008. The Subcommittee on Plant Health Diagnostic Standards (SPHDS) has been tasked with the development of a National Diagnostic Strategy for plant health, to assist with improving the diagnostic capacity and capability of Australia. This paper will present information highlighting the importance of coordination of diagnostic services to state and national biosecurity, and the process being undertaken by SPHDS as Australia works towards developing a National Diagnostic System.

Biography: Barbara Hall is a plant pathologist with over 30 years experience in diseases of Horticultural crops, and currently works as a Senior Research Scientist within the Horticulture Pathology Unit of the South Australian Research and Development Institute (SARDI). Barbara manages the Horticultural diagnostic service and the Quarantine unit within SARDI, overseeing the Post Entry Plant Quarantine Facility and ensuring the campus is compliant with AQIS requirements for receiving and handling quarantine material. Barbara coordinates and supervises research projects undertaken within the unit, and manages the South Australian component of several national vegetable pathology projects, both broad acre and greenhouse.

Estimating the diagnostic accuracy of tests used in emergency plant pathogen surveillance

Nichole Hammond, *Cooperative Research Centre for National Plant Biosecurity, Murdoch University and Department of Agriculture and Food, Western Australia* and Dominie Wright, *Cooperative Research Centre for National Plant Biosecurity and Murdoch University*

Field validation of diagnostic tests is an important component of developing national and international diagnostic protocols. In biosecurity, diagnostic tests are routinely used in surveillance activities and testing for compliance with phytosanitary standards. Validation of diagnostic tests includes optimisation of the assay, demonstration of the assay's performance characteristics and determining the 'fitness' of the test (consistency and accuracy) for the particular purpose for which it is being used.

Performance characteristics of the test commonly considered include the limit of detection (analytical sensitivity), and cross-reactivity (analytical specificity). Determining the accuracy of the diagnostic test for use with field samples is possibly more important. This is defined as the ability of the test to predict the infection status of the unit being tested correctly. In clinical sciences, the most commonly used measures of test accuracy are diagnostic sensitivity and specificity, and the positive and negative predictive values of the test. Although not a new concept in plant pathology, diagnostic accuracy is often not quantified in the development of new diagnostic tests.

In this paper we report on two studies conducted to estimate the diagnostic sensitivity and specificity of the traditional sieve-wash test and the new Enhanced Diagnostic Protocol for Detection of *Tilletia indica* (Karnal bunt) and other *Tilletia* spp. The first study used the traditional 2x2 contingency table using samples of known disease status (*T. indica*), or a "gold standard" test, to classify the samples. The second study used Bayesian methods to estimate the test accuracy in samples of unknown status, or in the absence of a "gold standard", using established *Tilletia* spp. in harvest samples as a model. The results of these studies provide estimates of the accuracy of the enhanced diagnostic test and thus the appropriateness of the test for use as a surveillance tool.

Biography: Nichole is undertaking a PhD at Murdoch University, Western Australia, and is supported by the Cooperative Research Centre for National Plant Biosecurity. Her PhD research is looking at methods for evaluating surveillance and surveillance tools for demonstrating freedom from plant pathogens.

Prior to undertaking her PhD Nichole worked for the Western Australian Department of Agriculture and Food for eight and a half years in a number of biosecurity related fields within the plant pathology section, including diagnostics, surveillance, pest risk analysis and plant health policy.

Simulating fire blight spread and establishment in Australia

Colin Hanbury, Maria J Sousa-Majer, John H Botha, Darryl C Hardie, *Department of Agriculture and Food, Western Australia and Cooperative Research Centre for National Plant Biosecurity,* Juan J G Adeva and Mark Reynolds, *School of Computer Science and Software Engineering, The University of Western Australia and Cooperative Research Centre for National Plant*

Fire blight (*Erwinia amylovora*) is a serious bacterial disease of apple and pear trees. Fire blight is suited to many apple and pear producing regions in Australia, and could reduce production by 50%. Its dispersal is complex, consisting of human transport, wind, rain and also insects visiting flowers. Fire blight was detected in Melbourne in 1997 and eradicated, and so is not known to be present in Australia. Primary infection is likely to be introduction of contaminated material, which then infects trees and produces cankers on trunks/branches. Bacterial ooze formed by these cankers is shifted by rain, hail, wind and insects to flowers where bees and other insects can rapidly spread bacteria to other flowers within an orchard. There have been at least three long-range international colonisations for fire blight – to Europe, North Africa and New Zealand – and so it is a likely future problem for Australia. At the Cooperative Research Centre for National Plant Biosecurity, data on species behaviour and dispersal will be used to test a prototype real-time simulation model that will be spatially linked to the risk site of interest and would allow more timely predictions of fire blight spread in urban, peri-urban and rural landscapes. The aim is to develop an appropriate generic modelling framework and simulation software technology that could be translated into an invasive plant pest-specific simulation system. If widely established, fire blight may be impossible to eradicate, and experience has shown steady spread across contiguous regions. A simulation model would need to consider risk points in the transport chain, proximity of these risks sites to suitable host environments, local topography and flowering times of tree varieties and the biology of the organism. This project will develop methods for designing optimal surveillance strategies that accounts quantitatively for these factors.

Biography: Colin Hanbury completed Bachelor of Science (Agriculture) in 1989 and a PhD in plant physiology in 1998, both from the University of Western Australia. He worked on adaptation and utilization of novel grain legume species from 1993 to 2003. He now works in horticultural biosecurity planning and incursion response for the Department of Agriculture and Food, Western Australia.

Vectoring of avian influenza antigens using a recombinant avian herpes virus vector

Risza Hartawan, Joanne Meers, *University of Queensland,* Tim Mahony and Karl Robinson, *Queensland Agricultural Biotechnology Centre*

The emergence of highly pathogenic avian influenza (HPAI) virus subtype H5N1 in Asia, Africa and Europe has resulted in massive economic repercussions in affected countries, and poses a continuing serious zoonotic threat. This panzootic is caused by influenza A virus (antisense segmented RNA) from the *Orthomyxoviridae* family, which is characterised by variant genotypes and high mutation rates. Vaccination has been implemented in several countries as part of comprehensive programs to control the disease in both poultry and human populations. However, current bird vaccination strategies generate unsatisfactory outcomes, due largely to the lack of an ideal vaccine against the disease. Numerous studies that employ genetic modification have been undertaken to produce an improved vaccine. The objective of this study is to explore the capacity of the naturally non-pathogenic virus Herpesvirus of Turkey (HVT) as a vector to express the main immunogens of HPAI H5N1 virus, which are haemagglutinin (H5) and neuraminidase (N1). Segments 4 (H5) and 6 (N1) of the virus genome that encode these proteins were analysed from a duck-derived field isolate of H5N1, and this information was used to design and construct synthetic H5 and N1 genes. These genes are being introduced into a HVT infectious clone using a bacterial recombination system. The expression level of the proteins of interest in the recombinant HVT is being evaluated by *in vitro* characterization methods. The vectoring system for H5N1 virus using HVT as a backbone will contribute to knowledge on the control of such highly genetically variable viruses.

Biography: Risza Hartawan is currently Master student of School of Veterinary Science (SVS), the University of Queensland, Brisbane. He has conducted his research at Department of Primary Industries and Fisheries (DPIF) Queensland. He is also a researcher of Indonesian Research Centre for Veterinary Science (IRCVS), Bogor, Indonesia. In 2005, he received a veterinary degree in Bogor Agricultural Institute, Indonesia.

Multiplex molecular detection of avian viral pathogens

Hans Heine, Victoria Boyd and Adam Foord, *CSIRO*

Avian viral pathogens can be devastating to animal and human health, food security and the economy of the affected industries and production systems. The timely detection and characterisation of these viruses is vital for the control of the spread and the treatment of disease. Influenza virus is a prime example of an avian virus with zoonotic and pandemic potential, but other agents such as West Nile virus and Newcastle disease virus can also cause human infections and disease. Diagnostic tools for simultaneous identification of many different viruses are required to support surveillance programs and enable rapid index case diagnosis. Early comprehensive diagnosis will facilitate risk assessment and the implementation of control measures in an outbreak. Novel multiplex molecular assays were developed on the Luminex platform using xTAG bead technology to detect and differentiate a range of avian viruses. Influenza virus, Newcastle disease virus, infectious bursal disease virus and Newcastle disease virus were used in a pilot study to evaluate the capabilities of the Luminex assays to detect and differentiate viruses, and to identify distinctive genetic bio-markers. The sensitivity and specificity of assays was compared to singleplex qPCR assays for diagnosis of each of the viruses.

Biography: Dr Hans Heine is a molecular biologist and project leader at the CSIRO Australian Animal Health Laboratory (AAHL) in Geelong. He has extensive experience in the development of novel diagnostic assays and technologies. Dr Heine has been a principal investigator for the Australian Biosecurity CRC for Emerging Disease.

Revision of the genus *Epiphyas* – the light brown apple moth in context

Bobbie Hitchcock, *CSIRO,* Andrew Mitchell, Marianne Horak, Mike Crisp and John Trueman

Epiphyas is a large genus of Australian moths (Family Tortricidae). Approximately 60 species are represented in the Australian National Insect Collection, with 66 names available for 38 of these and the rest undescribed. Our taxonomic knowledge of the genus is limited to Common's (1961) 6-page review, without illustrations of adults, and containing only a few drawings of genitalia.

Five species of *Epiphyas* are known to be widely polyphagous. Of these, *Epiphyas postvittana* (the light-brown apple moth) is a native pest that attacks various fruit crops such as apples, pears and citrus. It is listed as a quarantine threat by many countries, thereby placing restrictions on Australian fruit exports. Research into *E. postvittana* has long been hampered by taxonomic problems involving several similar-looking species.

The majority of *Epiphyas* species are apparently restricted to feeding on *Asteraceae*. The evidence for this is circumstantial however, and cannot refute suggestions that among the many undescribed *Epiphyas* species, other pests may be present. An inventory of Australian *Epiphyas* species and a scientific revision describing them – presented with an emphasis on the phylogenetic position of economically important species and combined with host plant information – should demonstrate which *Epiphyas* species are of concern to horticultural industries. Reliable identification tools, accessible to non-specialists, will help remove the threat of unjustified quarantine measures.

The outcomes of the revision, using a morphological approach to species identification, and presenting a phylogenetic interpretation based on molecular sequence data, are illustrated and discussed.

Biography: Bobbie is a PhD Candidate in the School of Biology at the Australian National University and the Cooperative Research Centre for National Plant Biosecurity at CSIRO Entomology in Canberra. Her supervisors are: Dr Marianne Horak at the Australian National Insect Collection, CSIRO Entomology, Canberra; Dr Andrew Mitchell, NSW Department of Primary Industries, Wagga Wagga; Professor Mike Crisp and Dr John Trueman, both in the School of Biology at the ANU in Canberra.

Bobbie has a First Class Honours degree in Chemistry from the Australian National University and a Bachelors degree in Zoology and Chemistry from La Trobe University, Melbourne, Australia.

Enhancing New Zealand's cattle identification and tracing systems: lessons from other systems worldwide

Christopher Houston, *MAF Biosecurity New Zealand,* I Govey, C King, K Creswell, Pearse A, D Heinz, B O'Brian, R Barnes, L Burton, D Birnie and S Keenan

To improve the capability to respond effectively to a biosecurity or food safety emergency and to ensure on-going consumer confidence in New Zealand's livestock produce, Government and industry organisations have come together to develop a new integrated system for the identification and tracing of livestock - the National Animal Identification and Tracing (NAIT) project. The scope of the proposed scheme is initially limited to cattle (and possibly deer), and regulations requiring compliance with new procedures to support NAIT are expected to be in place by 2011. A crucial step in designing the most cost effective and useful system for New Zealand has been to review and critically assess the approaches taken by other countries when designing and operating similar systems. These countries and territories included Great Britain, Canada, Australia, the USA, the Netherlands and South Korea, among others. The requirements, advice and guidelines published by a number of multinational or supranational organisations were also considered. This paper explains the key lessons and themes that have emerged from this work.

Biography: Chris Houston has worked as a Senior Adviser for MAF Biosecurity New Zealand since 2007 in animal disease surveillance and incursion response. Prior to joining MAFBNZ, Chris worked for the UK

Department for Environment, Food and Rural Affairs (defra) in Veterinary Surveillance and as part of the National Emergencies Epidemiology Group (NEEG).

Chris has a PhD in bacterial genetics and an MSc in Veterinary Epidemiology from the Royal Veterinary College.

Identification of effectors in *Venturia inaequalis*

Daniel Jones, Kim Plummer, *Cooperative Research Centre for National Plant Biosecurity and La Trobe University,* Lauren Jones, C Mesarich, G Hill, *Plant and Food Research and The University of Auckland*, Jo Bowen and Matthew Templeton, *Plant and Food Research*

Venturia inaequalis and *V. pirina* cause apple and pear scab (respectively). This project aims to identify and characterise effectors in these species and is supported by the Cooperative Research Centre for National Plant Biosecurity.

Effectors are pathogen proteins involved in infection. Effectors can also be recognised as foreign by plant receptors, which then initiate a signal transduction cascade that results in plant resistance. Breaking of resistance can occur if either the plant receptor gene or the effector gene is lost, or if the receptor is unable to recognise the effector due to a mutation. Such effectors often vary across species and races and could form the basis of an immunochemical or DNA-based assay to rapidly distinguish races and species.

Effectors are therefore of interest for three reasons: for their direct role in infection, for their role in activating plant resistance, and for use in developing molecular tests that can differentiate strains of *V. inaequalis* (including resistance-breaking strains) and species of *Venturia*. Such tests would be of use in surveillance, particularly in Western Australia, which is currently free of *V. inaequalis* but requires ongoing surveillance to verify area freedom.

We are sequencing the complete genome of *V. pirina* using pyrosequencing. The *V. inaequalis* genome is currently being sequenced, and will be used as a scaffold for *in silico* assembly of the *V. pirina* genome. Comparison and annotation of the genomes of these closely related species will follow. Additionally, the genome sequence of *V. inaequalis* is essential for rapid identification of any candidate effector proteins identified by 2-D DIGE (2-Dimensional Difference Gel Electrophoresis).

Using 2-D DIGE, we intend to compare proteins from *V. inaequalis* grown on cellophane/PDA culture against proteins produced in PDA culture, since previous work shows that *V. inaequalis* grows infection structures (stroma) on cellophane but not on PDA. Therefore, proteins present in cellophane culture may be involved in the formation of infection structures and may be important for infection. Proteins isolated by this method can be rapidly identified by comparing the mass of protein fragments to theoretical masses generated from analysis of the whole genome of *V. inaequalis*.

Biography: Daniel is a Cooperative Research Centre for National Plant Biosecurity Ph.D. candidate enrolled at the Department of Botany, La Trobe University. Most recently he was a biosecurity risk analyst at the Ministry of Agriculture and Forestry, New Zealand, assessing the biosecurity risk from import of Phaseolus spp. beans and table grapes. He has worked in a range of fields at the University of Auckland; development of virus tests in ornamental plants, microbiology of wastewater, stream ecology, and apple flowering genetics. He gained a M.Sc. at the University of Auckland and Scion (Rotorua) working on genetic mapping in two species of Pinus.

Optically encoded particle-based assays for high throughput biosecurity screening applications

Lie Kuo Liem, Darby Kozak, Bronwyn Battersby and Andrew Geering, *Nanomics BioSystem Pty Ltd*

The development and implementation of biosecurity diagnostics are a key Australian interest with regards to global health and national economic security. With the aim of creating a high throughput and customizable assay platform we have developed 21 optically encoded particles that can be surface modified to improve assay performance. These OptoPlex™ barcoded particles allow for multiple assays

to be performed in a single assay experimental set-up and analysed in a high throughput manner by any commercial flow cytometry. To date these particles have been used as genomic and proteomic assays towards biomarkers for infectious disease and cancer detection. This study presents the optimization of the oligo probe loading for 20, 40 and 60mer nucleic acid probe and target for the detection of equine influenza. The maximum probe loading decreased with increasing probe size. The developed generic assay platform outlined in this study can be readily applied to any number of genomic or proteomic biosecurity applications.

Biography: Lie Kuo Liem joined Nanomic BioSystem in April 2008, developing Optically Encoded Particle based Assay. Prior to this, he was working on tumour stem cells on human Glioblastoma at QBI.

He obtained his PhD in Anti-Cancer Drug Design from University of Bonn. He started his scientific career in Singapore at the IMCB, working in the area of DNA repair, and at Singapore General Hospital in clinical research on DPD deficiency in healthy and cancer patients. Prior to working in Australia, he conducted extensive research in the role of Environmental Mutagens/Carcinogens in DNA Repair at the Lawrence Berkeley National Laboratory, California.

Farm Biosecurity – a one stop shop for better practice

Jim McGrath, *Plant Health Australia* and Thea McNaught-Reynolds, *Animal Health Australia*

Animal Health Australia (AHA) and Plant Health Australia (PHA) are working together to implement the *Farm Biosecurity* program – a national awareness and engagement program which provides information about farm biosecurity and the prevention of animal disease and plant pests.

The aim of the *Farm Biosecurity* program is to improve producer awareness and raise understanding of biosecurity at the farm level nationally. It encourages producers to identify risks to their livestock and plant products, and minimise those risks through mitigation practices.

The program is the platform by which both organisations communicate with producers about agricultural pests, weeds and diseases, as well as the practices that can be adopted to manage these risks better. It supports the communications activities of AHA and PHA member organisations and provides a vehicle for consolidated future communications to producer audiences, removing duplication and increasing cut-through.

The *Farm Biosecurity* program has the strong commitment of AHA and PHA members, who are instrumental in the program's implementation and who are invited to contribute to the initiative.

Biography: Jim McGrath joined PHA as Communication Manager in November 2007. Jim has more than 15 years experience in communication, marketing and media liaison roles. His experience spans public and private sectors with stints at Centrelink, Department of Finance and Administration, Department of Health and Ageing (DoHA) and most recently as Communications Manager with AvSuper. While at DoHA Jim also had some exposure to biosecurity issues as part of a team working on a whole-of-government response to the Avian Influenza threat. Jim is responsible for the support of Plant Health Australia programs with communications, public relations and media activities.

Footwear as a biosecurity threat: defining the hazards and possible solutions

Mark McNeill, *AgResearch* and Craig Phillips

To be effective and efficient, efforts to prevent accidental transportation of invasive alien species (IAS) via international trade and travel must be underpinned by accurate data on the organisms that are present on different pathways. Transported soil has long been regarded as a significant risk due to its potential to harbour diverse IAS; though surprisingly few studies have documented the identity and viability of the organisms present. This has impeded robust risk analysis and efficient risk mitigation. Our research has begun to address this issue by identifying the hazards present in soil that had been intercepted by quarantine authorities from footwear of international airline passengers arriving at two New Zealand airports. The soil contained diverse bacteria, fungi, seeds and nematodes with high levels

of incidence and viability for all groups. Body parts of arthropods and several live mites also occurred in the samples. Many of the organisms found are regulated in New Zealand. There were significant positive relationships between soil weight and nematode numbers, and between soil weight and seed numbers. There was a negative relationship between soil age and microorganism viability. Moreover, soil arriving in New Zealand from the Northern Hemisphere winter appeared to present a relatively high risk. A preliminary comparison of our data with those from an earlier study of soil intercepted from shipping containers suggested that, on a per gram basis, soil on footwear harbours a particularly high density of viable organisms, perhaps because they receive greater protection from mortality factors such as temperature extremes, ultraviolet radiation and sea spray. The results indicated that there is potential to: (i) improve current soil treatments; (ii) identify and target particularly high risks within the footwear pathway; and (iii) to identify and target particularly high risks across all transport pathways for soil.

Biography: Mark McNeill leads a project on risks from transported soil in the NZ government funded research programme Better Border Biosecurity (B3) (www.b3nz.org). He has also been researching pathways for pest movement within New Zealand, and new surveillance methods for use at high risk sites such as seaports.

Molecular phylogeny of some important plant pathogenic smut fungi

Alistair McTaggart, *Cooperative Research Centre for National Plant Biosecurity,* Ben Callaghan, Roger Shivas, Andrew Geering, and Tanya Scharaschkin

Smut fungi are mainly pathogens of grasses (Poaceae) and several affect economically-important crop species such as rice, sugarcane, sorghum and maize. Within the Ustilaginaceae are three genera, *Ustilago, Sporisorium* and *Macalpinomyces*. Morphological characters are inadequate in differentiating these genera, leading to putatively polyphyletic groupings, which complicate the taxonomy and identification of these organisms. The objectives of this research are twofold: to create a stable and communicable taxonomy of smut fungi and to complement this new systematic information with innovative means for identification through modern diagnostic technologies.

Phylogenetic reconstruction using molecular and morphological data will be used to deduce monophyletic groups within the smut fungi so that the genera and species can be reclassified into a stable, communicable taxonomy. Molecular data has been obtained from one mitochondrial locus (COX3), three nuclear housekeeping genes (GAPDH, EF1α and RPB2) and the ITS region. Morphological traits have been scored and analysed separately and in combination with sequence data to investigate character evolution and to help resolve phylogenies. Phylogenetic trees have enabled inferences in character evolution in the smut fungi and their diversification on Australian grass hosts Phylogenetic hypotheses have been constructed using individual and concatenated data sets. Preliminary phylogenetic hypotheses from *circa* 50 taxa will be presented.

Biography: Alistair McTaggart is a Cooperative Reseach Centre for National Plant Biosecurity PhD student, enrolled through the Queensland University of Technology (QUT).

Pospiviroids in the West Australian sub-tropics: phylogeny, incidence and new hosts

Alison Mackie, Martin Barbetti, Brendan Rodoni, Simon McKirdy and Roger Jones, *Cooperative Research Centre for National Plant Biosecurity*

In 2008 Potato spindle tuber viroid (PSTVd) was detected for the first time in Streptoglossa sp., Conyza bonariensis (flaxleaf fleabane), Atriplex semilunaris (annual saltbush) and native Malvaceae species during a roadside verge survey in Carnarvon, Western Australia.

A survey was conducted between September 2009 and January 2010 during which over 2000 plant samples were collected to determine the prevalence of PSTVd on commercial plantations, roadside verges and common land in Carnarvon, Western Australia. The survey involved sampling volunteer tomato, capsicum or chilli plants and weeds, [including Apple of Peru (*Nicandra physalodes*), blackberry nightshade (*Solanum nigrum*) and flaxleaf fleabane (*Conyza bonariensis*)], growing alongside or near

commercial host crops. Weeds and native plants, [such as annual saltbush (*Atriplex semilunaris*) and various Malvaceae species] were collected along roadside verges and on common land in areas that were prone to flooding or were adjacent to commercial host crops.

- PSTVd has been detected in non-solanaceous plants in Carnarvon, WA.
- Detections of PSTVd and other pospiviroids, particularly in one or more seed producing countries outside of Australia, raise concerns about the possibility of new introductions into Australia.
- Pospiviroids including PSTVd have been detected in symptomless ornamental Solanaceae plants in Europe and New Zealand.
- At present, there is no restriction for this pathogen on seed imported into Australia of the following PSTVd host genera: *Capsicum, Petunia, Lycopersicon, Nicandra, Nicotiana, Physalis* and *Solanum*, with the exception of *S. tuberosum*.

All isolates previously detected in Carnarvon share 98-100% similarity to the "Chittering" isolate detected in Muchea, Western Australia in 2004. These isolates closely resemble the Dutch isolate (PSTVd-N) and New Zealand isolates as well as isolates from Narrikup, WA and from the Northern Territory, and from the United Kingdom. Researchers in the Netherlands have suggested that these groups of isolates may have originated in Oceania.

Whilst infection in tomato crops reduces yield and quality, the presence of PSTVd or other pospiviroids in Australia will have a significant impact on both production and export market access of potatoes. It is important to Australian horticulture that Australia remains free of this destructive pathogen.

Biography: Alison Mackie is currently a Cooperative Research Centre for National Plant Biosecurity student doing her PhD with University of Western Australia and Department of Agriculture and Food, WA. Alison's PhD project will investigate the phylogeny, pathogenicity and epidemiology of potato spindle tuber viroid (PSTVd) and related pospiviroids in Australia.

Alison has been employed by the Department of Agriculture and Food, Western Australia (DAFWA) since 1999 and has worked on a number of projects in the plant pathology section, including culture collection, diagnostics, surveillance and horticulture pathology.

Resistance monitoring and protocol development: key components in ensuring the biosecurity of post-harvest grain

Manoj Nayak, Patrick Collins, *Cooperative Research Centre for National Plant Biosecurity and Queensland Primary Industries and Fisheries,* Joanne Holloway, *Cooperative Research Centre for National Plant Biosecurity and NSW Department of Primary Industries*, Robert Emery, *Cooperative Research Centre for National Plant Biosecurity and Department of Agriculture and Food Western Australia,* Matthew Head and Robin Reid, *Cooperative Research Centre for National Plant Biosecurity and GrainCorp Operations Ltd*

Management of resistance to fumigants and contact insecticides in key stored grain pests plays a significant role in maintaining the biosecurity of Australia's $7billion grain industry. These materials are crucial to the grain industries ability to supply the 'insect-free' product demanded by both domestic and export markets. A major drawback, however, with this strategy is the threat of resistance in pest species.

Two key components of managing this threat are a national resistance monitoring program and the development of treatment protocols to combat resistance. The monitoring program provides information on the frequencies and levels of resistance in time and space and also early warning of the development of new resistance. A statistically robust, nationally agreed protocol is followed, which runs concurrently at three research laboratories representing each of the grain growing regions in Australia (Northern, Southern and Western). Information gathered is used to advise industry of regional and national trends and to identify where eradication, containment or other resistance management activities can be implemented.

The other key component is the development of effective treatment protocols to control newly emerged resistant biotypes. For example, once a new phosphine resistance is detected, a purified 'worst-case resistant strain' is established in the laboratory and fumigation protocols (including concentration,

exposure period, and temperature parameters) is developed. Close collaboration with industry ensures that the laboratory based protocols are validated through field trials before their adoption.

A successful outcome from this research program has been the management of strong resistance to phosphine in the lesser grain borer. This resistance problem was first detected in 2000 and posed a serious threat to post-harvest grain biosecurity. The latest threat is the emergence of very high-level resistance in flat grain beetle populations in central storages. Research is in progress to tackle this biosecurity problem.

Biography: Dr Manoj Nayak is a Senior Research Entomologist with the Queensland Primary Industries and Fisheries. His research expertise includes development of grain protectants, phosphine efficacy, resistance management and IPM in processed food. Currently Manoj leads two research projects within the Cooperative Research Centre for National Plant Biosecurity, one is a National program for monitoring resistance to chemical treatments in stored grain pests and the other is developing fumigation protocols to control strongly phosphine resistant Flat Grain Beetles. Manoj's expertise has earned him keynote invitations at international conferences and frequent invitations for peer-review of research papers for several international journals.

Validating feathers for the field diagnosis of highly pathogenic avian influenza subtype H5N1

Harimurti Nuradji, Hendra Wibawa, *University of Queensland and Australian Animal Health Laboratory, CSIRO Livestock Industries,* Sue Lowther, Jean Payne, Jennifer Rookes, John Bingham, *Australian Animal Health Laboratory, CSIRO Livestock Industries* and Joanne Meers, *University of Queensland*

Highly pathogenic avian influenza (HPAI) virus subtype H5N1 has resulted in serious consequences on public health, economics and animal health around the world. Active and passive surveillance based on rapid and accurate diagnosis plays a critical role in controlling this disease. Currently, cloacal and oropharyngeal swabs are the most commonly used sample types in rapid antigen detection tests. However, this approach may not provide reliable results because of bacterial contamination and the low levels of virus present in swabs. Several studies have reported high concentrations of H5N1 antigen in feather tissues. The aim of our study is to determine the distribution in chicken and duck feathers of an Indonesian duck-derived H5N1 virus and to validate feathers as a sample material for the field diagnosis of HPAI. Groups of 14 chickens and 14 ducks were challenged with a subclade 2.1.1 H5N1 virus. Cloacal swabs, oropharyngeal swabs and feathers were collected prior to challenge and at daily intervals from days 1 to 18 post-challenge. The concentration of virus in each sample type will be assessed by virus isolation and titration. Skin samples were collected for assessment of antigen by immunohistochemistry. The suitability of feathers for use as samples in rapid antigen detection tests will be assessed. This work has the potential to make a significant contribution to future surveillance and control of HPAI.

Biography: Harimurti graduated from Gadjah Mada University, Yogyakarta, Indonesia in 2003, She has been working in the Indonesia Center Research for Veterinary Science, Indonesian Ministry of Agriculture (BBalitvet), Bogor, Indonesia since 2007. She is a Postgraduate student in School of Veterinary Science at The University of Queensland in 2009.

Post harvest grain storage – from farmer to market

YongLin Ren, *Cooperative Research Centre National Plant Biosecurity, Canberra, Australian, School of Biological Science and Biotechnology, Murdoch University and Department of Agriculture and Food* and Chris Newman, *Department of Agriculture and Food*

Storing their own harvested grain for domestic and export markets is a new experience for many growers. Growers need to safeguard their product and ensure the on-farm storage and management systems adopted will enable outturn of grain to customer's specifications. Conditions stated in many contracts require freedom from insects and insect damage, foreign seeds, snails and mould and contamination from chemicals. Failure to adhere to the contract specifications will downgrade the commercial value of the entire parcel of grain. Stored grain insects are a problem across Australia, and the grain industry relies on phosphine fumigation to meet stringent market requirements for grain free

of insects. Phosphine is low cost and easy to apply in farm storages but resistance to phosphine has appeared, associated with continued use. Climate change has caused many insects to modify behaviour and there is a need to monitor those changes and determine how they might impact on grain storage.

The grain industry faces many challenges to ensure Australian grain maintains its reputation on the international and domestic market and the Cooperative Research Centre for Plant Biosecurity and the grain industry are studying alternative chemical and non-chemical methods to protect farm stored grain.

The study involves:

- Reviewing the outcomes of continual use of phosphine
- Optimising the use of aluminium phosphide formulations
- Investigating more efficient fumigant delivery systems
- Developing instruments to measure the output of aeration fans for farm storage
- Developing low cost gas monitoring equipment
- Investigating the integrity of grain storage facilities
- Investigating effective insect control on grain in harvest bags

There are many challenges to store grain on-farm post harvest and the outcomes from these projects will assist growers to ensure it is a profitable part of the farm enterprise.

Biography: YongLin has been employed as a principal scientist within the DAFWA. He is initially seconded to Murdoch University until June 2012 as Associate Professor. His main area of research on the postharvest biosecurity, grain storage, fumigant, fumigation, quarantine treatment, insect chemical ecology and he has 25 years research experience in the grain storage and quarantine treatment. YongLin, currently involves CRC research projects to contribute improve capacity and profitability of Australian's grain industry and develop new risk mitigation options that can contribute profitably to plant biosecurity, food safety and trade safety, and helping maintain the Australian grain industry position as a market leader in both domestic and international.

Individual–based modelling of the evolution and spread of resistance to pesticides in stored grain insect pests

Mingren Shi, *University of Western Australia and Cooperative Research Centre for National Plant Biosecurity,* Rob Emery, *Department of Agriculture and Food Western Australia and Cooperative Research Centre for National Plant Biosecurity* and Michael Renton, *University of Western Australia, Cooperative Research Centre for National Plant Biosecurity and CSIRO Sustainable*

Evolution of resistance to pesticides is widely recognized as a serious issue for the long-term sustainability of Australian agricultural systems. This is particularly critical when the pest management strategy is reliant on a single pesticide (phosphine), as is the case for the lesser grain borer. This study will develop individual-based models that incorporate processes such as organism life cycle and biology, effects of environment, genetics, sampling, effects of management, and spatial spread within and between storage facilities. The aim is to help predict population dynamics, the evolution of resistance, and the spread of individuals and resistance genes under different management scenarios and thus identify effective long-term strategies for monitoring and managing resistance.

We will present the structure and assumptions of a prototype version of the model, explaining how each beetle is represented separately. The way that environmental and management effects are simulated will be explained, as will the approach used to model genetics and resistance. Some preliminary results will be shown.

Biography: Mingren received his first PhD degree in Applied Mathematics from Murdoch University in 1997. He has worked as a Postdoc at UWA, as a Research Fellow at UNSW, and a lecturer in Statistics/Operations Research at USQ.

He enrolled to study for his 2nd PhD degree in Plant Biosecurity in April, 2009, at School of Plant Biology, UWA, under supervision of Michael Renton and Rob Emery.

Biosecurity – so simple it could make me cry! The use of analogies in understanding biosecurity concepts

Abu-baker Siddique, *Department of Agriculture and Food Western Australia,* David Cook, Art Diggle, Shuang Liu, Michael Hurley, Kim E Lowell and Isabel Arevalo-Vigne

Biosecurity is a global issue with complex elements. In the agricultural environment, biosecurity is aimed at protecting the biological resources from organisms by limiting the movement of plants, animals, machinery and people during trade, production, tourism and research activities. Increased global trading and tourism, enhanced by faster transportation, provide opportunities for organisms to travel rapidly around the world or within a location, which could lead to severe damage to the economy, environment, human health and community structure. Of the recent emerging diseases in plants, significant numbers of these are caused by exotic pests.

Despite the constant flow of information concerning biosecurity measures and requirements, adepts and converts are gained slowly. This seems to be related to a limited knowledge of cause and effect between people and impacted resources. Understanding biosecurity concepts has become an important issue to minimise pests from being introduced and spreading. While biosecurity policy builds on three concepts: a) 'keep out and stamp out' for pests that are not here; b) 'test and remove' for pests that are detected but not established; and c) 'advice and control' for those already established, biosecurity managers and policy makers face the problem of helping people understand the need to embrace biosecurity as a whole. To implement these policies it is necessary to raise biosecurity awareness among the public.

The use of analogies in science is a common practice to teach scientific principles and understand 'the way things work'. Analogies could help the wider community in understanding biosecurity concepts and the functions of biosecurity management in an agricultural context. Here we use onions as an analogy to visualize the multi-layer biosecurity concept while demonstrating the importance of individual layers against invaders. Other analogies could be drawn to help build the chain of thought needed in the conceptualization and abstraction of biosecurity.

Biography: Abu-Baker M. Siddique is a plant pathologist with the Department of Agriculture and Food – Western Australia (DAFWA). Following completion of his PhD in Canada he worked as a university lecturer in Bangladesh and carried out a number of post-doctoral research projects in the USA, Japan and Australia. Siddique joined the DAFWA in 2007 and is currently a member of an Enhanced Risk Analysis Tools project with the Cooperative Research Centre for National Plant Biosecurity, and partners Plant Health Australia, Horticulture Australia Limited, and the Rural Industries Research and Development Corporation.

The suppression and transmission of Phytophthora disease is assisted by fungicide application to plants

Amy Smith, Kirsty Bayliss, Simon McKirdy, *Cooperative Research Centre for National Plant Biosecurity,* Phil O'Brien, *Biological Sciences, Murdoch University* and Giles Hardy, *Centre for Phytophthora Science and Management, Murdoch University*

Some *Phytophthora* species are known to be among the most devastating plant pathogens worldwide, infecting a wide range of ornamental and agricultural crops as well as native plants. In the US, *P. ramorum* has wreaked havoc on natural and ornamental landscapes and *P. kernoviae* is another species of serious concern in the UK, and now also in New Zealand. It is thought that international and interstate plant trade is one of the main pathways for spread of these pathogens.

Sampling and testing for plants for the presence of disease is a labour-intensive and costly process. For most plants under inspection, health is assessed by observation of visible symptoms of disease. Recent research from both nursery surveys and controlled experiments has shown that viable *Phytophthora* propagules can be recovered from asymptomatic plant tissue. This may be due to the use of fungicides, which may not actually inhibit infection, but rather suppresses the pathogen. As time passes, treatments weaken so that pathogens become active, and infection is resumed.

Two on-going controlled glasshouse experiments are currently being conducted which test suppression of *Phytophthora* disease by fungicide, and the rate at which infection is resumed in new host plants when placed in contact with infected, fungicide-treated plant material. In the first experiment, plant seedlings were infected with *P. cinnamomi.* Plants were subsequently treated with one of three fungicides at a standard dose, and harvested over two years, with inspection for symptoms and recovery of the pathogen. In the second experiment, root material from all plants from each harvest used in the first experiment was buried in pots of healthy plants. These plants were monitored for disease expression, to determine the rate of transmission of the pathogen from fungicide-treated plant material. Preliminary results from these experiments will be discussed.

Biography: Amy Smith is a PhD candidate in her second year at Murdoch University in Perth, WA. Her project, "The Introduction, Transmission and Spread of Plant Pathogens in Plant Nurseries: using Phytophthora as a Model" is supported by the Cooperative Research Centre for National Plant Biosecurity.

When crops and climate collide: biosecurity threats associated with stabilizing rice production in Australia

Mark Stevens and Peter J Snell, *EH Graham Centre for Agricultural Innovation (NSW Department of Primary Industries and Charles Sturt University) and Yanco Agricultural Institute*

Rice production in Australia has been confined to the Murray and Murrumbidgee Valleys of southern New South Wales since commercial production in north Queensland ceased in 1993. Severe drought in south-eastern Australia since 2001 has drastically cut domestic rice production and this, in conjunction with high rice prices, has led to renewed interest in growing rice in north Queensland and in the Ord River Irrigation Area in northern Western Australia. Work is also underway to integrate rice production into agricultural systems around Mackay, Emerald (Queensland) and Lismore (northern New South Wales). The expansion of rice production into northern areas in order to access more reliable water supplies will result in increased levels of biosecurity risk. Northern crops are likely to be attacked both by the tropical pests present when rice was grown there previously, and also by polyphagous rice pests such as rice thrips (*Stenchaetothrips biformis*) which have established on alternate hosts in Queensland since commercial rice production ceased. Other significant obstacles to reintroducing rice production in northern areas include limited resistance to rice blast (*Magnaporthe grisea*) in commercially desirable rice varieties, and a shortage of agrochemicals registered for the control of tropical rice pests in Queensland and Western Australia.

Biography: Mark Stevens and Peter Snell are both with the NSW Department of Primary Industries, and are based at Yanco in southern NSW. Mark is a Principal Research Scientist with 20 years experience in rice pest research and management, and was heavily involved in developing the Rice Industry Biosecurity Plan in conjunction with industry and Plant Health Australia. Peter is a Rice Breeder with 12 years experience in developing new cultivars and assessing their response to biotic and abiotic stress.

Invasive diseases of cucurbits in Taiwan

Jiunn-Feng Su, Ting-Chen Deng, Shiow-Huey Hseu, Ying-Huey Cheng and Jye-Yann Liao, *Taiwan Agriculture Research Institute*

Cucurbitaceous plants are one of major sources of vegetables and fruits in Taiwan. However, the occurrence of diseases on those plants causes huge yield losses each year. Recently, the virus diseases have caused serious damage in muskmelon production in Tainan. More than NT 250 million

losses due to virus diseases caused by *Melon yellow spot virus* (MYSV) and *Watermelon silver mottle virus* (WSMoV) in 2006 and *Squash leaf curl Philippines virus* (SLCPHV) in 2008. The MYSV and WSMoV were transmitted by thrips, while SLCPHV was transmitted by whitefly. Effective control measures consist of vector elimination, vector population surveillance and collective disease management. Root rot/vine decline of muskmelon caused by *Monosporascus cannonballus* was first reported in 1995 in Taiwan. Sudden wilt of most infected plants occurs in the field 2 weeks before harvesting causing fruit immaturity and loss of market value. Field surveys showed that the hosts of *M. cannonballus* included muskmelon, Japanese cantaloupe, oriental pickling melon, cucumber, wax gourd and bottle gourd used as rootstock for watermelon in Taiwan. The disease is very serious on muskmelon around Taiwan. For the other 5 cucurbit plants the disease is limited to some locations or in greenhouses. Currently, there is no effective method for control of this disease. However, grafting appears to have control potential. Bacterial fruit blotch of watermelon caused by *Acidovorax avenae* subsp. *citrulli* was first reported in 1987 in Taiwan. The primary inoculum of this disease is from seeds. The symptoms of olive water soaking and chap on fruit surface greatly affect on market value of watermelon. Moreover, recent study showed the melon and bitter gourd were also hosts of this pathogen. The healthy seed production and strict quarantine can prevent the spreading of this pathogen.

Biography: Dr. Jiunn-Feng, Su is an assistant plant pathologist of Plant Pathology Division, Agricultural Research Institute, COA, Taiwan. Dr. Su worked on fungal diseases of cucurbits and orchids. His research interests are microbial ecology and disease management.

CropSafe®, protecting Victoria's grain industry through passive surveillance

John Taylor, *Victorian Department of Primary Industries*

Over one hundred agribusiness agronomists and private consultants have been engaged in a passive surveillance program known as *CropSafe*® . Experienced agronomists act as filters by identifying and screening out common and existing cereal and pulse crop pests and disease but submitting anything unknown, unusual or suspect for further diagnosis. These samples are then examined by DPI pathologists or entomologists, and if still unidentified or suspected as exotic then go on to further diagnostics. The *CropSafe* network effectively surveys hundreds of thousand of hectares of crop annually for exotics, providing valuable area freedom data. The *CropSafe* database provides comprehensive information about pest and disease occurrence and trends providing valuable feedback to industry. Major agribusiness and private consultancy networks have been engaged in the project on the basis of industry stewardship, training and capability enhancement and cost free timely and accurate diagnostics of samples. The principle at work is not an expectation that agronomists are proficient in the identification of exotics but that they are experienced in general crop pest and disease identification and management and therefore well placed to spot anything out of the usual.

CropSafe is a truly collaborative program that harnesses the knowledge, skill and good will of field agronomists to act as "first detectors" of potential exotic incursions that could decimate the grains industry. These agronomists and private consultants work for a range of employers and are often in direct competition in an aggressive market. The *CropSafe* program has successfully moulded these operators into a formidable collaborative team with a common goal of protecting Victoria's grain industry. The project has been running for three seasons with over 300 unknown samples submitted by first filter agronomists, of these 190 have gone through to laboratory diagnostics and 19 on for final level diagnostics with no exotics detected. In addition valuable negative data is collected to provide "known not to occur" evidence for claims of area freedom and market access.

CropSafe has developed, implemented, piloted and evaluated an ambitious industry biosecurity network that will help secure farms from exotic pest and disease incursions. The program is a significant step forward in ensuring the protection, sustainability and biodiversity of Victoria's grain industry.

The model is now being examined for expansion into the Horticulture and Vegetable industries

Biography: John Taylor is Plant Biosecurity Project Manager with the Victorian Department of Primary Industries(DPI). John has worked in the fields of extension, research, program management and regulation and compliance. He was the Ballarat district agronomist for four years and served as president of the Victorian Grasslands society in 1994. John has been instrumental in the development

of the small seed industry in Western Victoria and has made a significant contribution to revegetation efforts in Central Victoria. He managed the dryland salinity program in North Central Victoria, and has represented Victoria on various national forums. John has been Centre Manager at the DPI Bendigo office and Statewide Project Manager for all DPI's Centre Managers across the state. John currently works in the field of plant biosecurity and manages an $8.4 million statewide initiative titled "enhancing Victoria's Plant Biosecurity Capability" , a project initiated in response to the 2004 Auditor General 2004 report "beating the bugs".

BSES biosecurity: safeguarding the sweetest industry

Nicole Thompson, M Nader Sallam, Kathryn Braithwaite, Peter Samson, Robert Magarey, Barry Croft, *BSES Limited* and Regis Goebel, *CIRAD c/- BSES Limited*

BSES Limited is the principal provider of RD&E to the Australian sugar industry. Preparedness for exotic threats is a priority in BSES's Strategic Plan. BSES works closely with the Australian Quarantine and Inspection Service, Biosecurity Queensland and Plant Health Australia to protect the Australian sugar industry from exotic threats and to ensure a coordinated Emergency Response to pest or disease incursions.

BSES has developed Incursion Management Plans for major pests and diseases identified within the Sugar Industry Biosecurity Plan, including major moth borer species, *Eumetopina* planthoppers, sugarcane thrips, Ramu stunt, sugarcane downy mildew, mosaic viruses, phytoplasmas and other exotic diseases.

Pest and disease resistance screening is an integral part of the BSES plant breeding program. BSES imports sugarcane germplasm to exploit desired traits in the development of new varieties, and follows a strict quarantine regime of regular plant inspections, testing for exotic pathogens and 'seed' treatment before material is released to the program. Diagnostic tests developed or optimized by BSES for use in quarantine can also be used for pathogen identification at the time of an incursion. In addition BSES is screening Australian sugarcane germplasm for resistance to Ramu stunt, sugarcane downy mildew and *Sesamia* borer by investing in trials in Papua New Guinea. BSES has also conducted comprehensive surveys for sugarcane pests and diseases in Indonesia and PNG in collaboration with the Australian Centre for International Agricultural Research and the Indonesian Sugarcane Research Institute.

Revision of all Incursion Management Plans is in progress in light of lessons learnt from the sugarcane smut incursion of 2006. Potential threats, detection technologies and pest management methods are continuously evolving and it is a high priority for BSES to maintain vigilance in the face of continuous change.

Biography: Nicole Thompson is the Quarantine Pathologist at BSES Limited. She completed her PhD in plant virology at Adelaide University and has since worked in a variety of plant pathology research roles in Australia and the USA. She is involved in the safe transportation of sugarcane germplasm into and out of Australia and works to develop and implement diagnostic tests for exotic and endemic diseases of sugarcane.

Recent incursions of plant pathogens in the Northern Territory Australia

Lucy Tran-Nguyen, Barry Conde, Andrew Daly, Rachel Meldrum and Jose Liberato, *Northern Territory Department of Resources*

In recent times, two incursions of plant diseases have been detected in the Northern Territory:

1. Mango malformation disease on *Mangifera indica* (mango) caused by *Fusarium mangiferae*. This fungus was first detected in late 2007 at Coastal Plains Research Station, about 60 km east of Darwin. Since then, several surveys were undertaken and random samples were also collected by DoR staff and growers. So far *F. mangiferae* has been detected on three mango trees, which were destroyed.

2. *Cryptosporiopsis* leaf spot on *Citrus aurantiifolia* (West Indian limes and grapefruit) caused by *Cryptosporiopsis citri.* This fungus was first identified on a sample collected in November 2007 from a rural property outside Darwin (Ray *et al*. *Australasian Plant Disease Notes*, 2008, 3, 158–159). Three other detections of this disease have been detected in the NT.

All of these diagnoses highlight the importance of early detections in biosecurity related incursions which led to field surveys and prompt eradication strategies. It is well recognised that the Northern Territory is at the forefront of potential exotic incursions of plant pests from neighbouring countries. This has been exacerbated with increasing movement of people and imports from abroad.

Biography: Since 2007, Lucy Tran-Nguyen has worked in the Plant Pathology and Entomology branches at Plant Industries, NT DRDPIFR as the Molecular Diagnostician. Her work includes using molecular tools to diagnose plant pests (pathogen and insect). Projects include PCR diagnostics of grapevine leaf rust caused by *Phakopsora euvitis*, banana panama disease caused by *Fusarium oxysporum* f. sp. *cubense* tropical race 4, mango malformation disease, huanglongbing and phytoplasmas. Lucy is currently supervising a CRCNPB PhD student who is working on *Fusarium oxysporum* f. sp. *cubense* tropical race 4. Lucy is also involved in molecular taxonomy such as DNA barcoding to identify insects particular Lepidoptera of crop importance.

Characterisation and multiplexed detection of endemic and exotic begomovirus species in Australia

Sharon Van Brunschot, *Cooperative Research Centre for National Plant Biosecurity,* Paul Campbell, Denis Persley, John Thomas, Andrew Geering, *Queensland Primary Industries and Fisheries*, Juliane Henderson, Andre Drenth, *Tree Pathology Centre (The University of Queensland/ Queensland Primary Industries and Fisheries)* and Bronwyn Battersby, *Nanomics BioSystems Pty Ltd*

Begomoviruses (family *Geminiviridae*) cause economically important diseases on many dicotyledenous crop plants worldwide. Epidemics of begomoviruses are increasing in frequency due to the capacity of these viruses to evolve rapidly, the globalisation of trade, and the worldwide dispersal and polyphagous nature of the efficient whitefly vector *Bemisia tabaci* (B biotype).

In 2006, the exotic begomovirus *Tomato yellow leaf curl virus* (TYLCV) was detected for the first time in Australia in commercial tomato plantings surrounding Brisbane, the Lockyer Valley and Bundaberg (Queensland). The introduction of TYLCV has had a significant economical impact on tomato production, with disease incidence in some areas reaching 100%.

To investigate the identity of the introduced strains, the complete genomes of eight TYLCV isolates were sequenced. Phylogenetic analysis revealed two closely related (99% mean nucleotide diversity), but geographically segregated, clades. Clade A (Brisbane/ Lockyer Valley) was more closely related to TYLCV from California, than to Clade B (Bundaberg). Clade B was more closely related to TYLCV from China and Japan, than to Clade A. Several defective DNA components were detected from one TYLCV isolate from Brisbane, and characterised. These results suggest either two separate introductions of TYLCV into Australia, or alternatively a founder effect where a rare genetic variant in one region was introduced to a second region and became the predominant strain.

To limit further spread of TYLCV in Australia and to detect further incursions of exotic begomovirus species, rapid, efficient and reliable diagnostic strategies are required. Multiplexed real-time PCR diagnostic assays for the detection of endemic and exotic begomoviruses are being developed to improve the efficiency and accuracy of routine detection strategies. The overall aim of this research is to transfer the DNA probes to a nanosensor platform (OptoPlex™ beads), to enable the simultaneous detection of a virtually unlimited number of begomovirus species and strains.

Biography: Sharon Van Brunschot is a research PhD student supported by the Cooperative Research Centre for National Plant Biosecurity, Queensland Primary Industries and Fisheries (QPIF) and The University of Queensland (UQ). After completing her Science (Honours) degree in 2003, Sharon worked as a research assistant for the CRC for Tropical Plant Protection and QPIF. Her research was focused on the characterisation and development of diagnostic assays for a range of important fungal pathogens that affect horticultural industries in Australia. Sharon also recently developed the postgraduate course “Molecular Diagnostics in Plant Protection” for the School of Biological Sciences (UQ).

Development of a multiplexed immunoassay for the detection of banana viruses

Jenny Vo, *Queensland Primary Industries and Fisheries,* Paul Campbell, Kathleen Parmenter, Ben Callaghan, John Thomas, Hans Heine, Bronwyn Battersby and Andrew Geering

Banana is a very important staple food and export commodity in tropical regions of the world. Pathogens, including at least 20 different virus species, are major limiting factors to production. The primary means of control of these viruses is through the provision of clean planting material to farmers, for which good diagnostic methods are needed. Significant advantages could be achieved if all viruses could be detected simultaneously. The most feasible method for a multiplex assay is use of an antibody array as the banana streak viruses are endogenous pararetroviruses and nucleic acid assays are incapable of distinguishing integrated from actively replicating viral DNA. The objective of this project is to produce a diagnostic assay of this type.

For the antibody array, we plan to use the OptoPlex^{TM} nanosensors, which are optically-encoded, silica nanobeads that are analysed in a high throughput flow cytometer. Single chain variable fragments (scFvs) will be attached to these nanosensors and the virus detected in a sandwich assay using a fluorophore-labelled scFv.

Production of scFvs to each of the viruses is at different stages. ScFvs to *Banana bunchy top virus* and *Banana bract mosaic virus* have been cloned from mouse hybridoma cell cultures. The coat proteins of the badnaviruses causing banana streak disease are produced through the action of an aspartic protease on a polyprotein precursor and the boundaries of the coat protein have not yet been defined. We have purified *Banana streak Mys virus* and identified the putative coat protein. Protein samples are currently being analysed by MALDI-TOF/TOF to determine the amino acid sequence. Once characterized, these proteins will also be expressed *in vitro* in order to develop scFvs.

Biography: Jenny's interest is to develop new detection methods for detection of banana viruses. She is also interested in recombinant immunological reagents for detecting plant pathogens and the application of nanotechnology in plant pathogen diagnostics.

She is currently completing my PhD with the Cooperative Research Centre for National Plant Biosecurity. She is enrolled through the University of Queensland at the School of Australian Institute of Bioengineering and Nanotechnology. Her research is based at Queensland Primary Industries and Fisheries.

Improved delivery of extension messages through monitoring practice change during grape phylloxera area freedom re-zoning processes

John Whiting and Greg King, *Department of Primary Industries*

Determining area freedom is an integral part of a biosecurity program to upgrade the quarantine status of particular regions and provide better access to markets for produce. The Department of Primary Industries in Victoria is conducting a program to expand the areas known to be free of grape phylloxera (Phylloxera Exclusion Zones). During a three year process, grape and wine producers need to operate under the regulations that eventually accompany full declaration of area freedom. This requires them to change practices to meet the new regulations and an extension program was developed to assist producers make the necessary changes. Such changes were monitored in four regions by obtaining information by questionnaire at the commencement and end of the re-zoning process. Analysis of the data showed only 10-15% of grape and wine producers were required to change practices to meet the legislative requirements. Most producers operated within their own locality and were not required to change practices in response to the legislation. However, in the latter group, there were significant improvements in some practices associated with good vineyard hygiene and hence improved biosecurity against pests and diseases other than phylloxera. The degree of adoption of other practices did not change, suggesting a limit to adoption under present approaches and consideration should be given to modifying the extension program to engender further possible changes. Further practices demonstrated a relatively low level of adoption for which further extension programs or assistance could be developed. Identifying the producers in each particular group has enabled a more targeted approach to extension rather than a broadcast approach. Results from the monitoring of practice

change will be used to frame extension approaches in further pest and disease area freedom strategies.

Biography: John Whiting is a Horticulture Biosecurity Officer with the Department of Primary Industries in Victoria. His work areas have encompassed conducting research into the dried, table and wine grape industries in north west Victoria followed by further research and extension into vine improvement, canopy management, phylloxera, soil management and irrigation across central and southern Victoria. He has led the grape extension program in Victoria and more recently has been an Adoption Facilitator for the phylloxera re-zoning project.

Need organisms identified for biosecurity? Try DNA melting analysis

Louise Winder, *AgResearch,* Craig Phillips, Nicky Richards, Francisco Ochoa-Corona, Scott Hardwick and Cor Vink

Effective border biosecurity demands rapid and inexpensive identification of pests and pathogens. Traditional morphological identification of pests often requires specialist taxonomic expertise, and identification of plant pathogens typically depends on correctly diagnosing plant symptoms that can be ambiguous or cryptic.

Currently, many biosecurity identifications are achieved using DNA techniques, with DNA sequencing being the most popular. However recent developments with quantitative PCR and non-specific detection chemistries have led to DNA melting analysis whereby the dissociation temperature of a PCR product can be used to identify the pest or pathogen.

This poster describes our research on thermal dissociation of PCR-amplified DNA sequences, and their potential for identifying rapidly and inexpensively biosecurity risk organisms including insects, ticks and plant viruses. Melt-peak analysis is shown to be a rapid and reliable single-tube assay for the identification of biosecurity hazards.

Biography: Louise Winder has been working in science research since 1983. She is currently developing novel and rapid DNA protocols for identifying insects, mites and plant viruses, primarily for use by quarantine authorities such as MAF Biosecurity New Zealand. She also conducts research on molecular genetics of agricultural pests and their biological control agents with the aim of improving success rates and the efficacy of biological control programmes.

Invasion genetics of Russian Wheat Aphid: preliminary data from Western China

Bo Zhang, Susan Fuller, *Queensland University of Technology,* L Kang, *Chinese Academy of Sciences* and O Edwards, *CSIRO Entomology*

The Russian Wheat Aphid (*Diuraphis noxia*) is perhaps one of the greatest biosecurity threats to the grains industry in Australia. It is believed that *D. noxia* is endemic to western Asia, and has expanded its range to include sourthern Russia, the Middle East, Africa, Europe and the Americas. This species has become a major pest in grain production areas throughout the world, except for Australia.

The genetic relationships among endemic and invasive populations have not been examined previously. This study will use a unique combination of tools to study not only the background genetics of endemic and invasive populations (microsatellite and mitochondrial DNA markers), but also a group of genes known to influence feeding success and damage (salivary gland genes). These data will provide information on the invasion pathway of *D. noxia* and the mechanisms driving the colonization process i.e. have invasive clones arisen randomly from endemic populations, or have they arisen as a result of selection favouring a particular combination of traits (such as virulence).

Preliminary data has been obtained for 14 sites located throughout western China. Mitochondrial DNA data for 43 individuals indicates low genetic variability, with three haplotypes unique to western China and one haplotype found in a range of sites throughout western China and worldwide. Microsatellite data for six loci also indicates limited genetic variability with three loci monomorphic and the other three loci displaying between five and seven alleles/locus.

Biography: Ms Bo Zhang commenced her PhD research in January 2009 and has a scholarship from the CRCNPB. Ms Zhang is enrolled as an external student at QUT, and due to the nature of her project involving extensive field sampling in remote regions of western China, she is undertaking a significant proportion of her research at the Chinese Academy of Sciences.

Speakers Index

**Includes presentation times*

Cook	David	Monday, 1 March	Concurrent session 1 - Drivers	12.00pm	12.15pm	60
Cook	David	Tuesday, 2 March	Concurrent session 3 - Drivers	10.15am	10.30am	65
Crameri	Gary	Monday, 1 March	Concurrent session 1 - Threats	12.15pm	12.30pm	35
Croft	Barry	Tuesday, 2 March	Concurrent session 4 - Systems	11.45am	12.00pm	120
Day	Michael	Tuesday, 2 March	Concurrent session 5 - Drivers	1.30pm	1.45pm	69
De Lima	Francis	Wednesday, 3 March	Concurrent session 8 - Drivers	2.45pm	3.00pm	82
De Lima	Francis	Tuesday, 2 March	Concurrent session 5 - Systems	2.45pm	3.00pm	125
Delane	Rob	Monday, 1 March	Plenary 1	9.00am	9.45am	27
Dhand	Navneet	Tuesday, 2 March	Concurrent session 5 - Drivers	1.45pm	2.00pm	70
Dhand	Navneet	Tuesday, 2 March	Concurrent session 5 - Drivers	2.15pm	2.30pm	71
Dominiak	Bernie	Tuesday, 2 March	Concurrent session 5 - Knowledge	1.45pm	2.00pm	98
Emery	Robert	Tuesday, 2 March	Concurrent session 5 - Systems	2.15pm	2.30pm	124
Falk	Ian	Monday, 1 March	Concurrent session 1 - Systems	11.45am	12.00pm	111
Feutrill	Craig	Monday, 1 March	Concurrent session 1 - Threats	11.30am	11.45am	33
Field	Hume	Wednesday, 3 March	Concurrent session 6 - Drivers	9.45am	10.00am	73
Firestone	Simon	Wednesday, 3 March	Concurrent session 8 - Drivers	1.45pm	2.00pm	79
Franco-Dixon	Mary Ann	Monday, 1 March	Concurrent session 2 - Threats	2.30pm	2.45pm	38
Fraser	Greg	Monday, 1 March	Concurrent session 2 - Drivers	2.00pm	2.15pm	62
Freeman	Angela	Tuesday, 2 March	Concurrent session 4 - Drivers	11.45am	12.00pm	68
Garcia Adeva	Juan Jose	Wednesday, 3 March	Concurrent session 6 - Knowledge	10.00am	10.15am	101
Glanville	Ron	Tuesday, 2 March	Concurrent session 4 - Systems	11.15am	11.30am	119
Gonzalez	Felipe	Tuesday, 2 March	Concurrent session 4 - Threats	11.30am	11.45am	41
Gonzalez	Felipe	Wednesday, 3 March	Concurrent session 6 - Systems	9.45am	10.00am	125
Goswami	Sarah	Monday, 1 March	Concurrent session 2 - Threats	2.45pm	3.00pm	38
Greenslade	Penelope	Tuesday, 2 March	Concurrent session 5 - Knowledge	2.45pm	3.00pm	100
Griffin	Robert	Wednesday, 3 March	Plenary 6	9.00am	9.45am	30
Griffin	Robert	Wednesday, 3 March	Concurrent session 8 - Knowledge	1.45pm	2.00pm	106
Gunasekera	Don	Wednesday, 3 March	Concurrent session 7 - Systems	12.00pm	12.15pm	129
Hall	Barbara	Wednesday, 3 March	Concurrent session 7 - Knowledge	11.30am	11.45am	103
Hall	Barbara	Monday, 1 March	Concurrent session 2 - Systems	2.45pm	3.00pm	116
Hammond	Nichole	Tuesday, 2 March	Concurrent session 4 - Threats	12.00pm	12.15pm	42
Hauser	Cindy	Tuesday, 2 March	Concurrent session 3 - Threats	9.45am	10.00am	39
Hawkins	Chris	Tuesday, 2 March	Concurrent session 3 - Knowledge	10.15am	10.30am	93
Hayes	David	Monday, 1 March	Concurrent session 2 - Systems	2.15pm	2.30pm	115
Henderson	Wendy	Wednesday, 3 March	Concurrent session 7 - Drivers	11.15am	11.30am	76
Houston	Christopher	Tuesday, 2 March	Concurrent session 5 - Knowledge	2.00pm	2.15pm	98

Hulme	Philip	Tuesday, 2 March	Concurrent session 3 - Drivers	10.00am	10.15am	65
Hurley	Michael	Wednesday, 3 March	Concurrent session 7 - Systems	12.15pm	12.30pm	130
Ireland	Kylie	Monday, 1 March	Concurrent session 1 - Threats	12.00pm	12.15pm	34
Jackson	Louise	Tuesday, 2 March	Concurrent session 5 - Threats	2.15pm	2.30pm	46
Jarrad	Frith	Tuesday, 2 March	Concurrent session 3 - Systems	10.00am	10.15am	117
Jeggo	Martyn	Monday, 1 March	Concurrent session 2 - Drivers	2.15pm	2.30pm	63
Johnson	Stephen	Tuesday, 2 March	Concurrent session 5 - Systems	1.45pm	2.00pm	122
Jones	Roger	Tuesday, 2 March	Concurrent session 4 - Drivers	11.30am	11.45am	67
Jordan	David	Wednesday, 3 March	Concurrent session 7 - Systems	11.00am	11.15am	127
Kabay	Marc	Monday, 1 March	Concurrent session 1 - Knowledge	11.30am	11.45am	85
Khuwuthyakorn	Pattaraporn	Wednesday, 3 March	Concurrent session 8 - Threats	2.30pm	2.45pm	55
King	Jessica	Monday, 1 March	Concurrent session 1 - Threats	11.45am	12.00pm	33
Kompas	Tom	Monday, 1 March	Concurrent session 2 - Drivers	2.45pm	3.00pm	64
Kriticos	Darren	Tuesday, 2 March	Concurrent session 4 - Threats	11.45am	12.00pm	42
Kruger	Heleen	Wednesday, 3 March	Concurrent session 8 - Systems	2.45pm	3.00pm	133
Kuhnert	Petra	Wednesday, 3 March	Concurrent session 6 - Threats	10.00am	10.15am	48
Kuhnert	Petra	Monday, 1 March	Concurrent session 2 - Drivers	1.30pm	1.45pm	61
Kumar	Perdeep	Monday, 1 March	Concurrent session 2 - Drivers	2.30pm	2.45pm	63
Kung	Nina	Wednesday, 3 March	Concurrent session 7 - Threats	12.15pm	12.30pm	52
Lapidge	Steven	Monday, 1 March	Concurrent session 2 - Threats	1.45pm	2.00pm	36
Litaay	Theofransus	Monday, 1 March	Concurrent session 2 - Drivers	1.45pm	2.00pm	61
Liu	Shuang	Monday, 1 March	Concurrent session 1 - Drivers	11.30am	11.45am	59
Low	Tim	Wednesday, 3 March	Concurrent session 6 - Systems	10.15am	10.30am	126
Low Choy	Samantha	Tuesday, 2 March	Concurrent session 4 - Knowledge	11.30am	11.45am	95
Lowell	Kim	Tuesday, 2 March	Concurrent session 4 - Knowledge	12.00pm	12.15pm	96
Luck	Jo	Tuesday, 2 March	Concurrent session 4 - Drivers	11.15am	11.30am	67
Magarey	Roger	Monday, 1 March	Concurrent session 2 - Knowledge	1.45pm	2.00pm	88
Martin	Graeme	Tuesday, 2 March	Concurrent session 3 - Knowledge	9.45am	10.00am	92
Martin	Tony	Tuesday, 2 March	Concurrent session 4 - Knowledge	11.45am	12.00pm	95
McFarlane	Ro	Wednesday, 3 March	Concurrent session 8 - Systems	1.45pm	2.00pm	131
Meers	Joanne	Wednesday, 3 March	Concurrent session 7 - Threats	12.00pm	12.15pm	51
Meldrum	Jill	Wednesday, 3 March	Concurrent session 8 - Threats	2.00pm	2.15pm	53
Middleton	Deborah	Tuesday, 2 March	Concurrent session 4 - Threats	11.15am	11.30am	41
Mitchell	Andrew	Wednesday, 3 March	Concurrent session 7 - Knowledge	11.00am	11.15am	102
Moynihan	Kirsty	Wednesday, 3 March	Concurrent session 7 - Drivers	12.00pm	12.15pm	77
Moynihan	Kirsty	Tuesday, 2 March	Concurrent session 4 - Systems	12.15pm	12.30pm	121

Murphy	Brendan	Monday, 1 March	Concurrent session 1 - Drivers	12.15pm	12.30pm	60
Murphy	Brendan	Tuesday, 2 March	Concurrent session 3 - Drivers	9.45am	10.00am	64
Murray	Kris	Wednesday, 3 March	Concurrent session 7 - Threats	11.30am	11.45am	50
Newth	David	Monday, 1 March	Concurrent session 1 - Drivers	11.15am	11.30am	58
Nicholls	Trevor	Monday, 1 March	Concurrent session 2 - Knowledge	2.15pm	2.30pm	90
Nicholson	Jennifer	Wednesday, 3 March	Concurrent session 8 - Knowledge	2.00pm	2.15pm	107
Oakey	Jane	Monday, 1 March	Concurrent session 2 - Threats	1.30pm	1.45pm	35
Paini	Dean	Wednesday, 3 March	Concurrent session 8 - Systems	2.00pm	2.15pm	131
Pakula	Byron	Tuesday, 2 March	Concurrent session 5 - Knowledge	1.30pm	1.45pm	97
Pakula	Byron	Wednesday, 3 March	Concurrent session 6 - Knowledge	9.45am	10.00am	100
Panetta	Dane	Tuesday, 2 March	Concurrent session 5 - Systems	1.30pm	1.45pm	122
Parry	Hazel	Tuesday, 2 March	Concurrent session 4 - Drivers	11.00am	11.15am	66
Peacock	Tony	Wednesday, 3 March	Concurrent session 7 - Drivers	11.00am	11.15am	75
Peterson	Sophie	Wednesday, 3 March	Concurrent session 7 - Knowledge	12.00pm	12.15pm	104
Pluess	Therese	Wednesday, 3 March	Concurrent session 7 - Threats	11.00am	11.15am	49
Powell	Kevin	Tuesday, 2 March	Concurrent session 5 - Threats	2.45pm	3.00pm	47
Powell	Kevin	Wednesday, 3 March	Concurrent session 7 - Drivers	11.30am	11.45am	76
Prowse	Stephen	Wednesday, 3 March	Concurrent session 8 - Knowledge	2.45pm	3.00pm	108
Pugh	Merryn	Monday, 1 March	Concurrent session 1 - Systems	12.15pm	12.30pm	112
Rathe	Anna	Wednesday, 3 March	Concurrent session 8 - Drivers	1.30pm	1.45pm	79
Reeves	Rob	Monday, 1 March	Concurrent session 1 - Drivers	11.45am	12.00pm	59
Reynolds	Olivia	Tuesday, 2 March	Concurrent session 5 - Systems	2.30pm	2.45pm	124
Riddell	Debra	Monday, 1 March	Concurrent session 1 - Knowledge	12.00pm	12.15pm	87
Ridley	Andrew	Wednesday, 3 March	Concurrent session 6 - Drivers	10.15am	10.30am	74
Rodoni	Brendan	Wednesday, 3 March	Concurrent session 6 - Drivers	10.00am	10.15am	73
Rose	Karrie	Monday, 1 March	Concurrent session 1 - Knowledge	11.15am	11.30am	85
Rutherford	Stuart	Wednesday, 3 March	Concurrent session 7 - Drivers	11.45am	12.00pm	77
Savage	David	Tuesday, 2 March	Concurrent session 4 - Threats	11.00am	11.15am	40
Schemann	Kathrin	Tuesday, 2 March	Concurrent session 5 - Drivers	2.00pm	2.15pm	70
Schemann	Kathrin	Tuesday, 2 March	Concurrent session 4 - Systems	11.30am	11.45am	120
Schlipalius	David	Tuesday, 2 March	Concurrent session 5 - Threats	1.45pm	2.00pm	44
Scott-Orr	Helen	Tuesday, 2 March	Concurrent session 4 - Systems	12.00pm	12.15pm	121
Semeraro	Linda	Wednesday, 3 March	Concurrent session 8 - Threats	2.45pm	3.00pm	55
Sheppard	Andy	Monday, 1 March	Concurrent session 2 - Systems	1.30pm	1.45pm	113
Skerratt	Lee	Monday, 1 March	Concurrent session 1 - Systems	11.30am	11.45am	111
Sosnowski	Mark	Wednesday, 3 March	Concurrent session 8 - Drivers	2.15pm	2.30pm	80

Stanaway	Mark	Wednesday, 3 March	Concurrent session 8 - Systems	1.30pm	1.45pm	130
Stephenson	Barney	Monday, 1 March	Concurrent session 1 - Systems	12.00pm	12.15pm	112
Suckling	David Maxwell	Monday, 1 March	Concurrent session 2 - Threats	2.15pm	2.30pm	37
Taylor	Mel	Monday, 1 March	Concurrent session 1 - Systems	11.15am	11.30am	110
Taylor	Sharyn	Monday, 1 March	Concurrent session 2 - Systems	1.45pm	2.00pm	113
Tesoriero	Len	Wednesday, 3 March	Concurrent session 7 - Drivers	12.15pm	12.30pm	78
Thompson	Michael	Monday, 1 March	Concurrent session 1 - Knowledge	11.45am	12.00pm	86
Tolosa	Ximena	Wednesday, 3 March	Concurrent session 8 - Threats	1.45pm	2.00pm	53
Toribio	Jenny-Ann	Wednesday, 3 March	Concurrent session 8 - Systems	2.15pm	2.30pm	132
Turner	Rodney	Monday, 1 March	Concurrent session 2 - Systems	2.30pm	2.45pm	116
van Der Merwe	Johan	Tuesday, 2 March	Plenary 4	9.00am	9.45am	28
Walker	Ken	Tuesday, 2 March	Concurrent session 3 - Systems	10.15am	10.30am	118
Walshe	Terry	Tuesday, 2 March	Concurrent session 4 - Knowledge	12.15pm	12.30pm	96
Walters	Terrence	Wednesday, 3 March	Concurrent session 7 - Knowledge	11.45am	12.00pm	104
Warner	Simone	Tuesday, 2 March	Concurrent session 5 - Threats	1.30pm	1.45pm	44
Warner	Simone	Wednesday, 3 March	Concurrent session 8 - Threats	1.30pm	1.45pm	52
Weaver	John	Tuesday, 2 March	Concurrent session 4 - Drivers	12.15pm	12.30pm	69
Weaver	John	Wednesday, 3 March	Concurrent session 8 - Knowledge	2.30pm	2.45pm	108
Weiss	John	Wednesday, 3 March	Concurrent session 7 - Threats	11.45am	12.00pm	51
Wellings	Colin	Monday, 1 March	Concurrent session 1 - Threats	11.00am	11.15am	32
Whittington	Richard	Tuesday, 2 March	Concurrent session 5 - Drivers	2.45pm	3.00pm	72
Whittle	Peter	Tuesday, 2 March	Concurrent session 3 - Systems	9.45am	10.00am	117
Wibawa	Hendra	Monday, 1 March	Concurrent session 1 - Threats	11.15am	11.30am	32
Windsor	Peter	Tuesday, 2 March	Concurrent session 5 - Drivers	2.30pm	2.45pm	72
Woods	Rupert	Monday, 1 March	Concurrent session 2 - Knowledge	2.00pm	2.15pm	89
Woods	Bill	Wednesday, 3 March	Concurrent session 8 - Systems	2.30pm	2.45pm	132
Worner	Susan	Wednesday, 3 March	Concurrent session 7 - Systems	11.45am	12.00pm	128
Wright	Dominie	Wednesday, 3 March	Concurrent session 8 - Threats	2.15pm	2.30pm	54
Wright	Belinda	Monday, 1 March	Concurrent session 1 - Knowledge	12.15pm	12.30pm	87
Wright	Belinda	Monday, 1 March	Concurrent session 2 - Knowledge	1.30pm	1.45pm	88
Yemshanov	Denys	Tuesday, 2 March	Concurrent session 3 - Threats	10.15am	10.30am	39
Yemshanov	Denys	Wednesday, 3 March	Concurrent session 7 - Threats	11.15am	11.30am	49
Zappia	Rebecca	Tuesday, 2 March	Concurrent session 4 - Drivers	12.00pm	12.15pm	68
Zheng	Linda	Tuesday, 2 March	Concurrent session 5 - Threats	2.30pm	2.45pm	46