# 2019 Annual Meeting of the International Pest Risk Research Group

Globalization and pest invasions:
emerging risks and vulnerabilities


3-6 September 2019, Poznań, Poland

Hosted by the Institute of Plant Protection – National Research Institute, Poland, in conjunction with the European and Mediterranean Plant Protection Organization

Honour patronage:

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Dear Attendee,

Welcome to the twelfth annual meeting of the International Pest Risk Research Group. We move to Poznań, Poland after a very successful program last year in Taichung, Taiwan. The theme of our meeting this year is "Globalization and pest invasions: emerging risks and vulnerabilities". New trade partnerships and rapid expansion of infrastructure have intensified the trade and movement of forestry and agricultural products and other goods. The economic opportunities provided by globalization will, in turn, bring new and different invasive species risks. This year we wish to focus attention on this novel risk landscape to better understand and prepare for the emerging challenges in a globalized trade environment. We look forward to the opportunity to discuss efforts to improve and apply fundamental information, analytical methods, and uncertainty treatments for pest risk analysis.

This meeting would not have been possible without the efforts of the Institute of Plant Protection – National Research Institute, Poland (chaired by Dr. Tomasz Kałuski) and the European and Mediterranean Plant Protection Organization (EPPO) (chaired by Ms. Françoise Petter and Mr. Camille Picard). They have been responsible for all local arrangements. We thank them all! We are also extremely grateful to the CABI Invasive Species, Polish Ministry of Agriculture and Rural Development, Marshal of Wielkopolska Region for their sponsorship and Honour patronage of this meeting.

We hope you have a thought-provoking time in Poznań, Poland!

Kindly,

Chair: Prof. Darren Kriticos (CSIRO, Australia)
Vice-Chair: Dr. Denys Yemshanov (Natural Resources Canada, Canadian Forest Service, Canada)
Secretary-Treasurer: Dr. Senait Senay (University of Minnesota, USA)
Communications Officer: Dr. Frank Koch (USDA Forest Service, USA)
Student Representative: Dr. Ana Clariza Samayoa (National Chung Hsing University, Taiwan)
Local Organizing Committee: Dr. Tomasz Kałuski, Magdalena Gawlak and Daria Rzepecka (Institute of Plant Protection-NRI, Poland) and
Mr. Camille Picard (European and Mediterranean Plant Protection Organization)

## Day 1 – Tuesday, September 3, 2019

Location: Congress Centre of Institute of Plant Protection Building – NRI, 1th Floor, Rm. B

*Introduction to the meeting (Moderator: Frank Koch)*

8:15 Welcome to IPRRG 2019 – Darren Kriticos and Denys Yemshanov

8:30 Welcome to the Institute of Plant Protection – National Research Institute – *Roman Kierzek & Kinga Matysiak*

8:50 History of IPRRG: Accomplishments and intentions – *Darren Kriticos*

9:10 Plenary presentation - Polish Ministry of Agriculture and Rural Development

9:40 Plenary presentation - EFSA and EPPO PRA activities and how they contribute to biosecurity in Europe – *Ciro Gardi, Giuseppe Stancanelli & Françoise Petter*

10:10 Break

10:40 Brief introductions from meeting participants (*In 30 seconds or less, who are you, where are you from, for whom do you work, and why are you interested in this meeting?*)

*Combatting the Threats of Globalization (Moderator: Darren Kriticos)*

11:00 (1) Novelties in the plant health law of European Union: the high risk plants and the commodity risk assessment done by EFSA - *Ciro Gardi, Svetla Kozelska, Eduardo de la Peña, Stefano Preti, Maria Chiara Rosace & Giuseppe Stancanelli*

11:20 (2) Is biosecurity doing a good job in keeping invasive pests out? – *Karen Schneider & Edith Arndt*

11:40 (3) EPPO activities in 2018/2019 and Work Programme for 2019/2020 on pest risk assessment - *Camille Picard, Muriel Suffert, Rob Tanner, Fabienne Grousset & Francoise Petter*

12:00 Group photo! ☺

12:10 Lunch (Students- please meet with Ana Clariza Samayoa for a small gathering and networking opportunity)

1:25 Discussion of workgroup goals for the meeting – Darren Kriticos and Frank Koch

*Combatting the Threats of Globalization II (Moderator: Denys Yemshanov)*

1:40 (4) The Impact Indicator for Priority Pests (I2P2): a new plant pest ranking tool for the EU – *Berta Sánchez, Jesús Barreiro-Hurle, Emilio Rodríguez-Cerezo & Iria Soto-Embodas*

2:00 (5) The PRA Tool: combatting the threats of globalization and pest invasions with an authoritative workflow tool for risk assessment – *Laura S. Doughty, Lucinda Charles, Gareth Richards, Hannah Fielder, Lesley Mcgillivray, Katherine Cameron, Claire Curry, Nicola Wakefield & Roger Day*

2:20 (6) Development of an IPPC Guide to Engaging and Communicating with Stakeholders to support Pest Risk Analysis - *Alan MacLeod, Andrea Sissons, Melanie Newfield, Leanne Stewart & Sarah Brunel*

2:40 (7) East meets west or out of Africa? Genomic evidence and trade data to understand pest risks and globalization of *Spodoptera frugiperda* - *Wee Tek Tay, Daniele Kunz, Thomas*

*Walsh, Samia Elfekih Sharon Downes, Amanda Padovan, Darren Kriticos, Kiwoong Nam, Emmanuelle d'Alençon, Nicolas Nègre, Yidong Wu, Jianpeng Zhang, Cecilia Czepak, Michael Otim & Karl Gordon*

3:00 Break

*Pest Risk Analysis in Practice (Moderator: Frank Koch)*

3:30 (8) Right from the start: how risk management questions can make your PRA better – *Melanie Newfield*

3:50 (9) Pest risk assessment for selected pests – reports prepared in IPP – NRI in 2016-2018 – *Tomasz Kałuski, Agnieszka Błaszak, Michał Czyż, Magdalena Gawlak, Daria Rzepecka, Agata Olejniczak, Natasza Borodynko-Filas, Jakub Danielewicz, Renata Dobosz, Żaneta Fiedler, Elzbieta Gabała, Beata Hasiów- Jaroszewska, Joanna Kamasa, Tomasz Klejdysz, Franciszek Kornobis, Krzysztof Krawczyk, Wojciech Kubasik, Anna Maćkowiak-Sochacka, Julia Minicka, Katarzyna Pieczul, Katarzyna Sadowska, Przemysław Strażyński & Katarzyna Trzmiel*

4:10 (10) The UK Plant Health Risk Register – a rapid screening tool for new risks – *Anastasia Korycinska, Helen Anderson, Simon Lloyd, Claire Gent & Alan MacLeod*

4:30 (11) EPPO activities in PRA for invasive alien plants conducted within the framework of an EU funded LIFE Project - *Rob Tanner, Daniel Chapman, Oliver Pescott, Helen Roy & Camille Picard*

4:50 (12) Semi-automatic prioritization of species for pest risk analysis using the CABI Horizon Scanning Tool – *Alyssa J. Lowry, Pablo González-Moreno, Tim Adriaens, Tim Beale, Laura Doughty, Jodey Peyton, Helen E. Roy & Norbert Maczey*

5:10 Announcements

5:20 Adjourn

## Day 2 – Wednesday, September 4, 2019

Location: Congress Centre of Institute of Plant Protection - NRI, 1st Floor, Rm. B

8:15 Welcome to the day

*Inspections and surveillance (Moderator: Frank Koch)*

8:30 (13) Predictive propagule pressure reduction from biosecurity inspection – *Raphael Trouve & Andrew Robinson*

8:50 (14) Using climatic niche modelling techniques to target biosecurity inspection and surveillance effort in space and time: Asian Gypsy Moth and Oriental Fruit Fly – *Darren J. Kriticos, Dean Paini, Anna Szyniszewska & Noboru Ota*

9:10 (15) An adaptive survey design to delimit the geographic distribution of *Xylella fastidiosa* in Alicante, Spain – *Martina Cendoya, Elena Lázaro, David Conesa, Antonio López-Quílez, Vicente Dalmau, Amparo Ferrer-Matoses & Antonio Vicent*

9:30 (16) Cost-effective planning of multi-day pest survey campaigns – *Denys Yemshanov, Robert G. Haight, Christian MacQuarrie, Ning Liu, Frank H Koch, Robert Venette & Krista Ryall*

9:50 (17) Assessing the probability of freedom from pine wood nematode based on 19 years of

surveys – *Salla Hannunen & Juha Tuomola*

10:10 Break

10:40 (18) Sequential sampling plan for a regional management control of *Diaphorina citri* in Persian lime: *Citrus latifolia* Tan. in Mexico. – *Gabriel Diaz Padilla, Arroyo López, Isabel Jose, Panes Guajardo, Alberto Rafael & Ignacio Sánchez Cohen*

11:00 (19) Optimizing delimitation survey grids for insect pests – *Hui Fang, Godshen R. Pallipparambil, Nicholas C. Manoukis & Barney P. Caton*

*Assessing Pest Risks and Impacts (moderator – Darren Kriticos)*

11:20 (20) The potential economic loss of chili industry in China caused by *Bactrocera latifrons* (Hendel) based on @RISK – *Delin Kang, Zhihong Li, Hongyu Sun, Yujia Qin, Guocai Lu & Shuai Lan*

11:40 (21) Street palms and potential impacts of palm pests on USA Mainland – *Frank H. Koch, Mark J. Ambrose, F.D. Cowett, Alan Burney & Olya Rysin*

12:00 Working lunch and a poster session; **short talks on posters** and interaction with poster presenters. Short talks provide an opportunity for poster presenters to say a few words about their work to the group. "Short talks" are meant to be less than 8 minutes. They are completely optional but are encouraged.

2:00 (22) The hemlock looper, *Lambdina fiscellaria* Guenée, 1857, and other threats to *Picea sitchensis* (Bong.) Carr. plantations in Europe via the horticultural trade – *Melanie G. Tuffen, Rachel Wisdom & Sheila Nolan*

2:20 (23) Black soldier fly *Hermetia illucens* (Diptera: Stratiomyidae) population dynamics model to explore waste management areas in Taiwan – *Ana. C. Samayoa, Darren J. Kriticos & Shaw-Yhi Hwang*

2:40 (24) Risk management measures for fall armyworm (*Spodoptera frugiperda*) in Taiwan - *Shih-Tsai Yang & Yu-Bing Huang*

3:00 (25) Red Palm Weevil, *Rhynchophorus ferrugineus* records in Georgia and the innovative phytosanitary measures for eradication – *Mariam Chubinishvili & Manana Kakhadze*

3:20 Break

3:50 Workgroup session: Pest Risk Analysis and Environmental Sustainability Reporting

4:20 IPPRG and International Year of Plant Health – potential joint activities and group events

5:20 Adjourn

## Day 3 – Thursday, September 5, 2019

Location: Congress Centre of Institute of Plant Protection - NRI, 1st Floor, Rm. B

8:10 Welcome to the day

*Modelling and mapping potential distribution and spread (Moderator: Frank Koch)*

8:20 (26) Assessing the potential distribution of Asian gypsy moth in Canada: A comparison of two methodological approaches – *Vivek Srivastava, Verena C. Griess & Melody Keena*

8:40 (27) Predicting the spotted lanternfly dispersal in the United States – *Yu Takeuchi, Chris Jones, Anna Petrasova, Vaclac Petras, Helena Mitasova, Glenn Fowler & Ross Meentemeyer*

9:00 (28) A case study of *Bemisia tabaci* in north-west Europe and assessment of potential future establishment in the United Kingdom under climate change – *Catherine Bradshaw, Deborah Hemming, Richard Baker, Matthew Everatt, Dominic Eyre & Anastasia Korycinska*

9:20 (29) Mapping and predicting the potential distribution of western flower thrips (*Frankliniella occidentalis* Pergande) in Taiwan - *Feng-Chyi Lin, Yi-Ju Chen & Yu-Bing Huang*

9:40 (30) Potential distribution and impact of climate change scenarios on Fall armyworm, *Spodoptera frugiperda* in Asia with particular reference to India: Assessment through CLIMEX – *Vaddi Sridhar*

10:00 Break

10:30 (31) Pest risk assessment techniques and climate change: Improving climate suitability for *Bemisia tabaci* in East and Central Africa correlates with increased prevalence of whiteflies and cassava diseases- *Darren J. Kriticos, Ross E. Darnell, Tania Yonow, Noboru Ota, Laura M. Boykin, Robert W. Sutherst, Hazel Parry, Habibu Mugerwa, M.N. Maruthi, Susan Seal, John Colvin, Sarina Macfadyen, Andrew Kalyebi, Andrew Hulthen and Paul J. De Barro*

10:50 (32) Target population environments and pest distribution modelling: An approach towards pest prioritization and preparedness – *Sharma Mamta, G. Ramanagouda, Us. Sharath Chandran, Kholova Jana, Ahmed M. Irshad*

11:10 (33) Potential geographical distribution of fall armyworm (*Spodoptera frugiperda*) in China - *Yujia Qin, Shuai Lan, Zihua Zhao, Hongyu Sun, Xiaoming Zhu, Puyun Yang, Zhihong Li*

11:30 Break to prepare for technical excursion. Comfortable clothing and walking shoes are recommended

12:00 Lunch

*Technical excursion with lunch (all times are approximate)*

1:00 - Bus to technical excursion

Technical excursion (site visit and discussion)

2:00 - 3:00 Visit Arboretum – Institute of Dendrology in Kornik - ( *http://www.idpan.poznan.pl/home-eng* )
3:00 - 4:00 Bus to field station of the Institute of Plant Protection
4:00 - 5:30 Visit field station of the Institute of Plant Protection in Winna Gora
5:30 – 6:30 Return to Poznan

7:00 Group Dinner – At the Figa restaurant, Plewiska ( *https://www.figarestauracja.pl/* )

## Day 4 – Friday, September 6, 2019

Location: Congress Centre of Institute of Plant Protection - NRI, 1st Floor, Rm. B

8:15 Welcome to the day

*New methods for analyzing pest risk (Moderator: Denys Yemshanov)*

8:30 (34) Aligning incentives in import supply chains: a carrots and sticks approach – *Susie Hester*

8:50 (35) A matter of survival: a simple model for the detection of an invasive species under surveillance – *Andrew P. Robinson, John Kean & Melissa Welsh*

9:10 (36) A multi-model approach to predicting emerald ash borer infestations – *Kishan Sambaraju, Kathryn Powell, Robert Lavallée & Andre Beaudoin*

9:30 (37) Influence of Methyl salicylate (MeSA) applied to eggplant on the behavior of *Thrips palmi* Karny (Thysanoptera: Thripidae) and its natural enemy *Orius strigicollis* Poppius (Hemiptera: Anthocoridae) - *Shan-Guan Syu & Shaw-Yhi Hwang*

9:50 (38) Revisiting the use of Self-Organizing Maps (SOM) to predict to risk of invasion of re-emergent pest species – *Karl A. Suiter & Godshen R. Pallipparambil*

10:10 Break

*IPPRG Business Meeting*

10:40 Presentation of IPPRG 2019 award winners

10:50 *Past, present, and future of IPRRG: getting down to business.* All are invited to attend this important meeting, which provides an opportunity for members to understand the operations of IPRRG, to inform IPRRG leaders of specific needs, and to help shape the direction of the organization. (Please consult the handout for critical information)

1. What will we accomplish in this meeting? (Chair)
2. IPRRG membership status report (Secretary-Treasurer)
3. IPRRG finances / balance sheet (Secretary-Treasurer)
4. Communications issues (Communications Officer)
5. Student issues (Student Representative)
6. When and where is our next get-together? (Chair / Vice Chair)
   a. Host nominations and proposals for IPPRG 2020 and beyond (open to any IPRRG member)
   b. Discussion of host nominations / proposals
7. Is there anything else we haven't covered?

12:20 Adjourn

## Posters:

**Biology, bioclimatic modelling, and phytosanitary risk assessment of box tree moth, *Cydalima perspectalis* (Walker), in Canada -** *Abdullahi Ameen & Martin Damus*

**Retrospective Analysis of PestLens Articles on Exotic Pests, 2008-2018** - Barney P. Caton, John S. Rogers & Carissa Marasas

**The RHS plant health strategy** - *Fryni Drizou, Melanie Tuffen, Rebekah Robinson & Gerard Clover*

**Screening potential pests of Nordic coniferous forests associated with trade of ornamental plants** - *Mariela Marinova-Todorova, Niklas Björklund, Johanna Bobera, Daniel Flø, Juha Tuomola, Micael Wendell, Salla Hannunen*

**Application of a systematic methodology to create a pest list database for high risk plant commodities** - *Stefano Preti, Maria Chiara Rosace, Svetla Kozelska, Eduardo de la Peña, Irene Muñoz-Guajardo, Giuseppe Stancanelli & Ciro Gardi*

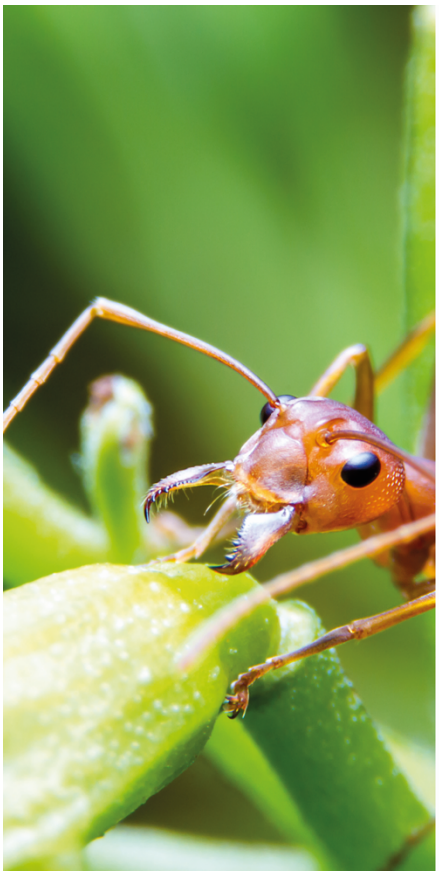
**Performing an Expert Knowledge Elicitation (EKE) to estimate the likelihood of pest freedom for high risk plant commodities** - *Maria Chiara Rosace, Stefano Preti, Svetla Kozelska, Eduardo de la Peña, Olaf Mosbach-Schulz, Giuseppe Stancanelli & Ciro Gardi*

**EPPO platform on Pest Risk Analysis –** *Muriel Suffert, Damien Griessinger & Françoise Petter*

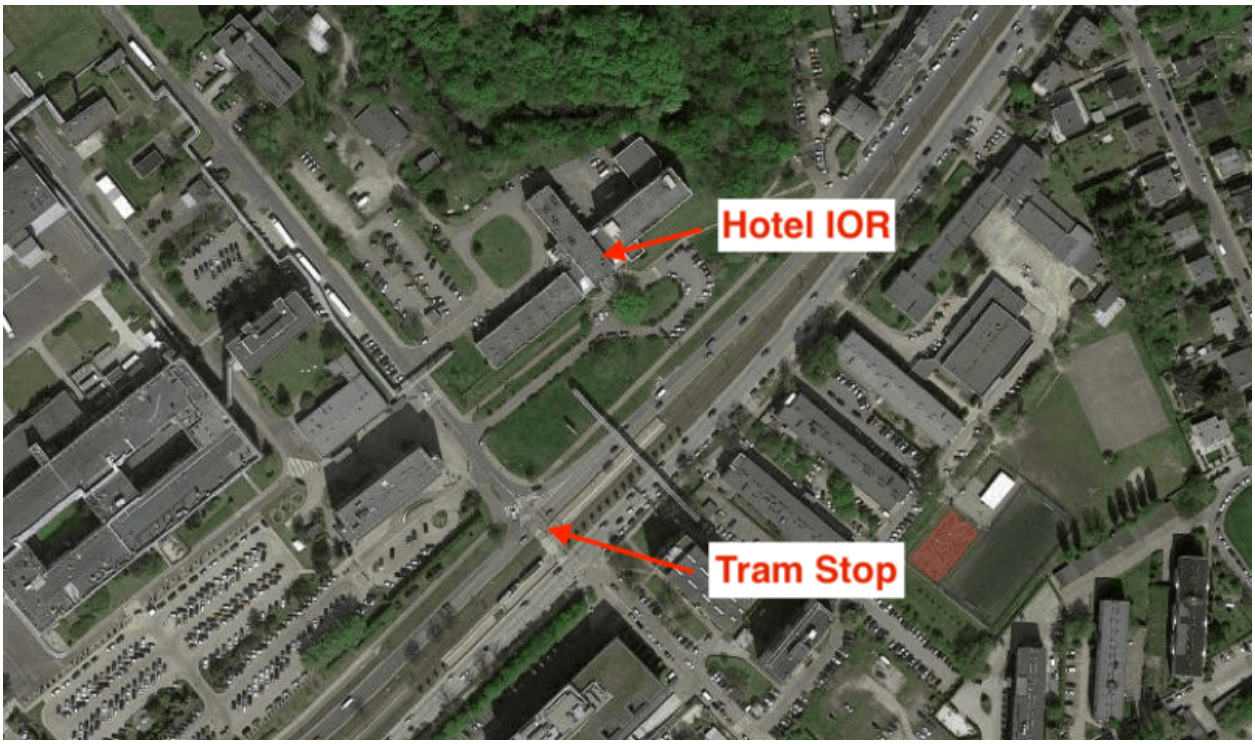
**Inverse modelling of invasion risk for different invasion phases of forest tree pests in HOMED** - *Robbert van der Dool, JC (Bob) Douma & Wopke van der Werf*

**Comparison of invasive pests in China and the United States** - *Yannan Wang & Zihua Zhao*

**Potential geographical distribution prediction and overlap analysis of two invasive species - *Bactrocera dorsalis* (Hendel) and *Ceratitis capitata* (Wiedemann)** - *Yu Zhang & Zihua Zhao*



## Directions to the Institute of Plant Protection




**Directions to the Institute of Plant Protection - NRI:**

The meeting will take place in auditorium „B" on the 1st floor of the Congress Centre of the Institute of Plant Protection - NRI (Wladyslawa Wegorka 20, Poznan).

The hotel is in the same building. From any other hotel in Poznan, you should take tram #1, 6, 13 or 15 (direction: Junikowo or Budziszynska). Please leave the tram at the stop "Wegorka". The Congress Centre is on your right side, across the street.

## Abstracts to Oral Presentations

## (Arranged in order of presentation)

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**EFSA and EPPO PRA activities and how they contribute to biosecurity in Europe**

Ciro Gardi[1]*, Giuseppe Stancanelli[1] & Françoise Petter[2]*

[1]European Food Safety Authority (EFSA), Plant Health Team, Parma, Italy
[2]European and Mediterranean Plant Protection Organization (EPPO: https://www.eppo.int/), Paris, France
*presenting authors

For more information, contact: Ciro.GARDI@efsa.europa.eu; petter@eppo.int

Pest risk analysis (PRA) in Europe has a long history. It is conducted mainly by two organizations: EPPO (for the its 52 Member Countries from European and Mediterranean countries as well as eastern and central Asian countries) and EFSA (for its 30 Member Countries, which include the 28 European Union (EU) Member States but also Iceland and Norway). Individual countries also carry out their own PRAs. EFSA and EPPO conduct pest risk analyses at supra national level producing fit for purpose assessments (from pest categorisation and express PRA to quantitative pest risk assessments) but also provide guidance on how to conduct PRAs to their Member Countries. Both EFSA and EPPO develop and follow PRA guidance and standards which are based on ISPM 11. The system in place in both organizations will be presented as well as how their recommendations are used by risk managers to strengthen plant health biosecurity in Europe.

EPPO.
Since its creation in 1951, one of EPPO's main priorities is to prevent the introduction of dangerous pests from other parts of the world, and to limit their spread within the region should they be introduced. In order to achieve this objective, the Organization identifies pests which may present a risk and provide an early warning to its member countries via the Alert List. If needed a Pest Risk Analysis (PRA) is carried out to evaluate in detail the risk for the EPPO region and to identify phytosanitary measures which can be taken against these pests. The EPPO PRA Standards (EPPO, 2011 & 2012) are based on ISPM 11. Dedicated EPPO Expert Working Groups regularly conduct PRAs on specific pests or groups of pests. PRAs prepared including the measures recommended are then reviewed by different groups to make a formal recommendation to EPPO member countries. EPPO Standards are used throughout the region by national authorities carrying PRAs. National PRAs are also used to make recommendations. In order to promote exchange of information on PRAs, the EPPO Platform on PRA (pra.eppo.int) was recently established.

EFSA
EFSA, an EU agency, is the EU body for risk assessment in food and feed safety, animal health, animal welfare and plant health. It was set up in 2002, following a series of food crises in the late 1990s, to be a source of scientific advice and communication on risks associated with the food chain. EFSA started its activities in plant health in 2006. Current EFSA activities in plant health include PRAs, commodity risk assessments, impact assessment for prioritisation of quarantine plant pests, support to MSs on risk

bases surveillance, horizon scanning for new plant pests by media and literature monitoring, databases on pests of particular concern for the EU. PRAs are conducted with a two-phase approach: the first phase is a rapid and descriptive pest categorisation; in a second phase, after consultation with risk managers, a quantitative pest risk assessment with uncertainties analysis is conducted, allowing for quantitative comparison of different scenarios. EFSA and EPPO cooperate by sharing information and work programmes and by co-organising joint activities, such as scientific workshops and conferences.

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**(1) Novelties in the plant health law of European Union: the high risk plants and the commodity risk assessment done by EFSA**

Ciro Gardi[1*], Svetla Kozelska[1], Eduardo de la Peña[1], Stefano Preti[1], Maria Chiara Rosace[1] & Giuseppe Stancanelli[1]

[1]European Food Safety Authority (EFSA); [*]presenting author

For more information, contact Ciro.GARDI@efsa.europa.eu

The new Plant Health Law (Reg.(EU) 2016/2031) increases the prevention against the introduction of new pests via imports from non-EU countries and introduce the concept of high risk plants. With the Implementing Regulation (EU) 2018/2019 the European Commission establishes the list of high risk plants, the introduction of which into the EU territory will be provisionally prohibited from 14 December 2019 until a full risk assessment has been carried out. The list includes 36 genera and two species comprising plants for planting, plants, fruits and wood. The rules concerning the procedure to be followed in order to carry out the risk assessment of high risk plants are detailed in Commission Implementing Regulation (EU) 2018/2018. EFSA was requested to perform the commodity risk assessment on the high risk plants dossiers submitted by non-EU countries. As basis for these activities, EFSA has published: i) a Technical Report indicating the content that must be considered and included when preparing high risk plants (HRP) dossiers and ii) a Guidance explaining how the commodity risk assessments will be performed once the dossier is accepted by EFSA. A communication campaign and a webinar were also held in order to increase transparency on the process and engagement with stakeholders. In this document a synthesis of the EFSA activities on HRP and of the methodology proposed is presented.

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**(2) Is biosecurity doing a good job in keeping invasive pests out?**

Karen Schneider[1] & Edith Arndt[1*]

[1]Centre of Excellence for Biosecurity Risk Analysis, University of Melbourne, Victoria, Australia; [*]presenting author

For more information, contact edith.arndt@unimelb.edu.au

With globalisation and increases in trade volumes comes the risk of emerging invasive pests that can adversely affect the environment, economy, amenity and human health. Biosecurity systems worldwide are designed to protect these assets from the negative impacts associated with entry, establishment and

spread of exotic pests. Whether any biosecurity system can achieve its primary goal, to keep areas free of exotic pests, depends on how well the system performs its tasks. Australia, an island nation, has a mature and complex biosecurity system. It consists of many components, including multiple participants, extensive resource inputs, many separate but linked activities and multi-layered objectives. To evaluate whether Australia's biosecurity system is "healthy", as defined by a set of evaluative criteria (effectiveness, efficiency, resilience, capacity and sustainability), we developed an evaluation framework for the system on national level. The framework, developed in collaboration with a number of stakeholders, represents novel work in the field of biosecurity. It aims to provide the means for identifying risk and vulnerabilities in the system, and areas where improvement is needed. Policy makers can implement the framework to assess performance at the system level but can also adapt it to lower level evaluation of particular components of the biosecurity system, such as activities to anticipate risk. Evaluation outcomes can effectively communicate risks to policy makers who can base future investment decisions on this evidence.

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**(3) EPPO activities in 2018/2019 and Work Programme for 2019/2020 on pest risk assessment**

Camille Picard[1*], Muriel Suffert[1], Rob Tanner[1], Fabienne Grousset[1] & Francoise Petter[1]

[1]European and Mediterranean Plant Protection Organization (EPPO), Paris, France; [*]presenting author

For more information, contact cp@eppo.int

EPPO is an intergovernmental organization responsible for cooperation in plant health within the Euro-Mediterranean region. Following the terms of the International Plant Protection Convention (IPPC), EPPO is a Regional Plant Protection Organization. At EPPO, the identification of priorities for Pest Risk Analysis (PRA) on pests other than plants relies on expert judgment and is mainly based on the EPPO Alert List. PRAs are performed following the EPPO Decision-Support Scheme for an Express Pest Risk Analysis (PM 5/5(1)). In 2018/2019, EPPO performed PRAs on three insects and one invasive alien plant: *Agrilus bilineatus, A. fleischeri* (Coleoptera: Buprestidae), *Naupactus xanthographus* (Coleoptera: Curculionidae) and *Ambrosia trifida* (Asteraceae). In addition, a study on bark and ambrosia beetles of non-coniferous wood has been finalized. The presentation will provide information about the progress made on these different topics. In 2019/2020, EPPO Work Programme on risk assessment will include a PRA on Tomato brown rugose fruit virus (*Tobamovirus*), and possibly *Gymnandrosoma aurantianum* (Lepidoptera: Tortricidae), a Study on viruses of grapevine breeding material, the finalization of a buffer zone guidance document, as well as the development of risk management measures for *Meloidogyne ethiopica, M. luci* and *M. graminicola* on the basis of national PRAs. The EPPO Secretariat is also compiling risk management measures included in EPPO recommendations over the last 10 years into a database, with the objective to enhance consistency in identifying phytosanitary measures. EPPO is also considering allowing non-EPPO countries to upload their own PRAs on the EPPO PRA platform (https://pra.eppo.int/).

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**(4) The Impact Indicator for Priority Pests (I2P2): a new plant pest ranking tool for the EU**

Berta Sánchez[1*], Jesús Barreiro-Hurle[1], Emilio Rodríguez-Cerezo[1] & Iria Soto-Embodas[1]

[1]European Commission-Joint Research Centre (JRC), Seville, Spain; [*]presenting author

For more information, contact Berta.Sanchez@ec.europa.eu

The Impact Indicator for Priority Pests (I2P2) is a composite indicator to rank plant pests according to the severity of the impacts they can cause. It aggregates 25 measurable indicators covering economic, social and environmental dimensions building on the criteria set by Regulation (EU) 2016/2031 for the identification of "priority pests". The I2P2 has been used to assess the impact of a list of 28 plant pests jointly selected by the European Commission and the Member States. The I2P2 is tailored to the specificities of the data available for the different type of hosts with three index versions: pests affecting crops, pests affecting forestry and pests affecting both. The I2P2 ranking results are robust to both methodological assumptions and uncertainty of the underlying data. A sensitivity analysis was carried out for alternative weights scenarios given to the three dimensions. Uncertainty was considered for the data provided by EFSA on biophysical impacts (e.g., yield and quality loss, rate of spread and time to detection). The ranking of pests following the application of the I2P2 has provided the European Commission and the Member States a solid evidence base from which to select a preliminary list of priority pests, as referred to in Article 6(2) of Regulation (EU) 2016/2031. The list will entry into force and application by December 2019 after stakeholder consultation. Those priority pests will be subject of surveying, contingency plans, simulation exercises and action plans in the EU member states.

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**(5) The PRA Tool: combatting the threats of globalization and pest invasions with an authoritative workflow tool for risk assessment**

Laura S. Doughty[1*], Lucinda Charles[1], Gareth Richards[1], Hannah Fielder[1], Lesley Mcgillivray[1], Katherine Cameron[1], Claire Curry[1], Nicola Wakefield[1] & Roger Day[1]

[1]CAB International (CABI); [*]presenting author

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We describe development of a system to support selection of measures for reducing risk associated with pest species and facilitate safe movement of plants and plant products. The PRA Tool is built as a feature of the Crop Protection Compendium (CPC). Interrogation of CPC data generates and categorizes pest lists associated with a commodity pathway. Risk assessments for individual pests or each pest associated with a commodity pathway can be completed using a template following standards set out by the International Plant Protection Convention (IPPC, ISPMs 2 and 11). Each stage adds to the compilation of a summary report that can be output, edited and used under a Creative Commons Attribution 2.0 Generic (CC BY 2.0) licence. Requirements gathering activities, before development, included an on-line survey, a workshop with 29 representative risk assessors from 14 countries in sub-Saharan Africa, and demonstration and discussion of design concepts with expert groups. The beta version was launched in December 2018 at a workshop for 28 risk analysts from 11 sub-Saharan African countries and is available

to all CPC subscribers for trial. The final version will be launched in October 2019. Sustainability and updating of data are assured by off-setting costs against revenue, whilst CABI commits to provide both the CPC and PRA Tool for free to the registered NPPOs in 97 low-income countries. The PRA Tool was developed as part of CABI's Action on Invasives programme, which is supported by UK Aid (Department for International Development) and Directorate-General for International Cooperation (DGIS), Netherlands.

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**(6) Development of an IPPC Guide to Engaging and Communicating with Stakeholders to support Pest Risk Analysis**

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Through the development and implementation of phytosanitary policies and activities the International Plant Protection Convention (IPPC) aims to secure coordinated and effective action to prevent and to control the introduction and spread of pests of plants and plant products. At a country scale, these activities are the responsibility of the national plant protection organization (NPPO). Whilst an NPPO has responsibility for phytosanitary actions, it cannot operate in isolation and relies on engagement with other bodies, the private sector and civil society. Through exchange of information, stakeholders can contribute significantly to NPPO decision making and the development of phytosanitary regulations based on pest risk analysis (PRA). NPPO engagement with stakeholders during the process of PRA is essential. This paper will outline how a guide to stakeholder engagement and risk communication was developed for the IPPC. The principles that underlie good risk communication are identified together with key factors to consider before communicating about pest risks. The presentation will draw on case studies from around the world to provide examples of risk communication techniques applied in practice.

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**(7) East meets West or Out of Africa? Genomic evidence and trade data to understand pest risks and globalization of Spodoptera frugiperda**

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Accurate genomic knowledge can be used to understand and predict global spread patterns of invasive pests. A case in point is the current high-profile global detections of the invasive noctuid moth fall armyworm (FAW) *Spodoptera frugiperda* that included both corn-preferred and rice-preferred pest species complex. Since first reported in 2016 in West Africa, FAW has now been detected in at least 60 countries, including all of sub-Saharan Africa, and parts of the Middle East and Asia. A current theory for the spread of this pest species might be termed the 'out of Africa' hypothesis; wherein African populations spread eastwards to the Middle-East, Asia and South East Asia in a stepping-stone manner via natural dispersal. The chronological order of reported detections, while patchy, is largely congruent with this hypothesis. However, genomic evidence has largely been lacking from these globally diverse populations for testing of this hypothesis and to identify potential origins of native populations. Here, we present findings on genomic signatures of both corn- and rice-preferred FAW populations from across their native and invasive ranges, incorporating data from global agricultural and horticultural trade patterns, to understand the role of globalization in the spread of FAW. We show that the spread of FAW has a strong link to trade pathways, with implications for biosecurity interventions for managing the spread of FAW and similar pests. We demonstrate how genomic evidence has an important role to play in revealing spread patterns for pests, and hence understanding emerging pest pathway risks.

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**(8) Right from the start: how risk management questions can make your PRA better**

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A PRA (Pest Risk Analysis) can be used for a wide range of different decisions, including the application of phytosanitary measures. However the link between the PRA and the decisions made based on it is not always clear. In some cases, decisions based on PRAs can be unexpected, even to those who prepared the PRA. An unclear link between the PRA and the decision based on it can result in disputes with trading partners and stakeholders. One method for improving the link between a PRA and decision-making is to formulate specific risk management questions. These questions are developed by decision makers in discussion with risk analysts. At the New Zealand Ministry for Primary Industries, risk management questions are routinely used in this way for food safety risk assessment. A pilot of this method was done for the development and review of phytosanitary import requirements for two plant commodities. Results from this pilot suggest that the use of specific risk management questions developed in participation between decision makers, stakeholders and risk analysts has the potential to

improve the clarity of the PRA and the transparency of decision-making, as well as reducing the time taken to conduct PRA.

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**(9) Pest risk assessment for selected pests – reports prepared in IPP – NRI in 2016-2018**

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The summary of 69 Pest Risk Assessments prepared in Institute of Plant Protection – NRI in Poznan in 2016-2018 as part of long-term programme financed by Ministry of Agriculture and Rural Development will be presented. PRAs were prepared for: *Agrilus anxius, A. planipennis, Aleurothrixus trachoides, Anthonomus signatus, Apiosporina morbosa, Bactericera tremblayi, B. trigonica, Bactrocera dorsalis*, beet curly top virus, *Cacoecimorpha pronubana, Candidatus Liberibacter solanacearum*, *Candidatus Phytoplasma solani, Choristoneura lafauryana, Citrus bark cracking viroid, Cnephasia longana, C. pumicana, Cochliobolus carbonum*, cocksfoot mottle virus, *Coniferiporia weirii, Dendrolimus sibiricus, Diaporthe vaccinia, Dickeya dianthicola, Entoleuca mammata, Fusarium circinatum, F. foetens, Globodera capensis, G. ellingtonae*, grapevine syrah virus 1(GSYV10), *Heliothis zea*, hop stunt viroid, *Lgutettix oculatus*, *Keiferia lycopersicella, Liriomyza huidobrensis, Longidorus diadecturus, Macrophomina phaseolina, Massicus raddei, Meloidogyne chitwoodi, M. ethiopica, M. fallax, M. luci, Nacobbus aberrans, Neodiprion abietis, Neonectria neomacrospora, Phyllosticta solitaria, Phytophthora chrysanthemi, Phytophthora lateralis, Puccinia pittieriana, Radopholus similis, Rhagoletis complete, Scirrhia acicula, Sirococcus tsugae, Spodoptera frugiperda, Stegophora ulmea, Thekopsora minima, Thrips setosus, ,Tilletia indica*, tobacco ringspot virus, tomato apical stunt viroid, tomato leaf curl New Delhi virus, tomato ringspot nepovirus, tomato yellow ring virus, *Viteus vitifoliae*, *Xanthomonas arboricola pv. pruni, Xanthomonas fragariae, Xiphinema californicum, Xylella fastidiosa, Xylosandrus compactus, Zaprionus indianus.* Pest risk assessments were prepared based on express PRA scheme published by European and Mediterranean Plant Protection Organization modified according to new plant health law in EU (Regulation 2016/2031).

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**(10) The UK Plant Health Risk Register – a rapid screening tool for new risks**

Anastasia Korycinska[1*], Helen Anderson[1], Simon Lloyd[1], Claire Gent[1] & Alan MacLeod[1]

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The UK Plant Health Risk Register (RR) is a publically available UK pest risk ranking system. The first 658 pests were added in 2013. Since then, the RR has continued to grow steadily as new pest threats are identified and assessed through this rapid screening tool, and it now contains around 1040 pests. Scores to rank pests are generated from simple rules and calculations requiring (relatively) little background information. The score generation will be explained and caveats discussed. Supporting text on the biology of the pest and RR scores are presented to key policy makers to aid prioritisation of actions. The RR has become the primary tool for communicating new and altered pest risks in the UK between risk analysts, policy makers and industry. The RR is dynamic, with significant new information leading to review of existing pest scores. The functioning of the RR itself is also reviewed and, where appropriate, processes adjusted. The presentation will cover three examples: a) recalibrating one of the calculation matrices when analysis showed the calculated values were consistently altered by analysts' judgement, b) the addition of uncertainty and c) the ability to stop updating low-risk pests (archiving) to help manage the maintenance burden. The RR is now being used for a wide variety of purposes by government, academics, industry and others. A key difficulty with this is communicating the limitations inherent in the RR data to outside users.

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**(11) EPPO activities in PRA for invasive alien plants conducted within the framework of an EU funded LIFE Project**

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Since 2002, EPPO has conducted prioritization and Pest Risk Analysis (PRA) of invasive alien plant species. In 2015, EPPO was awarded an EU funded project to conduct PRAs on invasive alien plants to support the EU Regulation 1143/2014 on the prevention and management of the introduction and spread of invasive alien species. Here the results of 16 PRAs prepared in the framework of the project are presented: *Ambrosia confertiflora, Andropogon virginicus, Cardiospermum grandiflorum, Cinnamomum camphora, Cortaderia jubata, Ehrharta calycina, Gymnocoronis spilanthoides, Hakea sericea, Humulus scandens, Hygrophila polysperma, Lespedeza cuneata, Lygodium japonicum, Pistia stratiotes, Prosopis juliflora, Salvinia molesta* & *Triadica sebifera*, which include species either present and absent from the region. Each of the 16 species was prioritised and identified as a high priority for PRA using the EPPO prioritisation process for invasive alien plants which was adapted to suit EU needs specifically for the project. The outcome of this process is compared with the conclusions of the PRA. Additionally, priority entry and spread pathways and measures to mitigate the future impact of the species into and within the EPPO region are presented. Finally, the likelihood of establishment based on the species life forms and species distribution modelling highlight biogeographical regions most at risk within the EPPO region.

**(12) Semi-automatic prioritization of species for pest risk analysis using the CABI Horizon Scanning Tool**

Alyssa J. Lowry[1*], Pablo González-Moreno[2], Tim Adriaens[3], Tim Beale[4], Laura Doughty[5], Jodey Peyton[1], Helen E. Roy[1] & Norbert Maczey[1]

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In 2018 CABI launched the Horizon Scanning Tool (HST), an online decision system to help identify potential invasive species threats to a given territory. Using information from CABI's Compendia the tool generates a list of invasive species absent from the selected "area at risk" but present in the "source area". The user can suggest source areas based on neighbouring countries, countries linked by trade or transport, or countries sharing similar climates. Currently the output from the HST are extensive species lists which provide a good first basis for identifying potential invasive species. To prioritize species for risk assessment and make the output of the HST more meaningful, CABI aims to implement a semi-automatic procedure that prioritizes invasive species that could be introduced and established in a given territory. This new approach is being developed and tested using St. Helena island, as a case study. Here, in 2018, an expert-based workshop, generated a list of priority species that could arrive on St. Helena and cause harm to biodiversity, economy, and human health. The HST output was compared with this expert list to determine how well the CABI HST could identify species that are a potential threat to St Helena. Using data already available in the CABI Compendia, we aimed to model the probability that the species in the HST output would also be on the expert-based list. A boosted regression tree analysis, found the total number of records and the number of hosts a potential to be key indicators.

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**(13) Predictive propagule pressure reduction from biosecurity inspection**

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The introduction of invasive plants with global trade is one of the most important socio-ecological challenge worldwide. One major option to reduce the introduction of invasion species is border inspection, i.e., reducing the risk at point of entry. Biosecurity inspection has most often been framed as an acceptance sampling problem at the consignment-level, i.e., inspecting each incoming consignment until we are confident that its infestation rate is below a chosen threshold. However, at the pathway-

level, we currently lack a method to interpret the effect of inspection in terms of a risk assessment model (risk = probability of invasion times consequences).

Here, we provide an analytical framework and derive an explicit formula to predict propagule pressure reduction that arise from inspecting a pathway. We illustrate our approach on several plant invasion pathways to Australia and New Zealand. We show that the risk reduction factor associated with an inspection can vary by more than one order of magnitude among pathways. Theoretical analysis reveals that we can predict the effectiveness of an inspection from the characteristics of the pathway. Reframing biosecurity inspection within the framework of the risk assessment model not only allows optimising the allocation of sampling effort for inspection, but it also allows comparing inspection effects with other potential risk reduction measures.

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**(14) Using climatic niche modelling techniques to target biosecurity inspection and surveillance effort in space and time: Asian Gypsy Moth and Oriental Fruit Fly**

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The global shipping network is widely recognized as a pathway for vectoring invasive species. There are two main types of biosecurity concerns from shipping: pests that are associated with the ship itself, and those that are associated with the materials being shipped. In the case of the ship-borne risks the risk of an incursion is spatially most closely-related to the immediate environs of the port, and hence the habitat suitability of these locations is an important factor influencing the establishment risk for pests that disperse in this manner. For invasive species that are inadvertently transported in association with goods that are transported via shipping, the risks are more spatially dispersed, as shipping containers are now typically devanned close to markets away from the port of entry. Inspection of goods and packaging and their transportation vehicle is a critical element in any biosecurity system. Given limited resources for this activity, its effectiveness will depend at least partially on how well the effort is targeted to risky pathways. We use two case studies to demonstrate CLIMEX modelling techniques that support the targeting of surveillance efforts in space and time based on climate suitability for two high-impact pests. We model the threat patterns posed by *Lymantria dispar* (gypsy moth) as an example of a ship-borne pest invasion threat, and *Bactrocera dorsalis* (Oriental Fruit Fly) as a pest associated with fresh produce.

## (15) An adaptive survey design to delimit the geographic distribution of *Xylella fastidiosa* in Alicante, Spain

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*Xylella fastidiosa* (Xf) is a quarantine pathogen in the European Union (EU). In June 2017, Xf presence was confirmed in Alicante Province, central-eastern Spain. According to Decision (EU) 2015/789 a demarcated area of 5 km radius around the positive findings was established. Surveillance was performed to update the disease geographic distribution and plan subsequent eradication. Survey activities comprise visual inspections and symptomatic plant sampling in 0.1 $km^2$ grid cells in the first km radius around the positives and in 1 $km^2$ cells in the rest of the demarcated area. Based on surveillance data this work aimed i) to estimate the spatial variation in disease incidence; and ii) to optimise the efficiency of delimiting surveys. Disease incidence was modelled by means of a Bayesian spatial hierarchical model using INLA. Spatial and climatic factors were considered, including Purcell's risk categories based on minimum temperature. Climatic covariates were not relevant in the model and Xf was detected in all Purcell's categories. Moreover, the spatial structure had a central role in the distribution of disease incidence. A delimiting survey strategy was designed based on a three-phase adaptive approach in which the epidemiological unit size (grid cell) and sampling intensity were tailored according to the previous phase information. An algorithm was implemented to optimise the number of surveyed epidemiological units and the sample size by simulating random sampling scenarios. The proposed adaptive survey design correctly delimited the geographic extent of the disease, but reducing the number of surveyed cells and increasing sampling intensity.

## (16) Cost-effective planning of multi-day pest survey campaigns

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Surveillance is critical for timely detection of pest invasions. We propose a model that allocates daily survey routes in a multi-day survey campaign aimed to detect an infestation. We adopt a team orienteering problem to plan daily inspections during the survey campaign and use an acceptance sampling approach to develop an optimal surveillance strategy for emerald ash borer (EAB) in Winnipeg, Manitoba, Canada. The manager's problem is to select daily routes and determine the optimal number of trees to inspect with a particular inspection method in each site subject to upper bounds on a survey budget, daily inspection time and the total length of the survey campaign. We compare optimal survey strategies computed with two different management objectives. The first objective maximizes the expected area with detected infestations. The second objective minimizes the expected number of undetected infested trees in sites that were not surveyed or where the surveys did not find signs of infestation. The choice of management objective influences the survey strategy. We also explore the impact of uncertainty about site infestation rates and detection probabilities on the surveillance strategy. Accounting for the uncertainty addresses possible temporal and spatial variation in infestation rates and helps develop a more robust survey strategy. The approach is generalizable and can support delimiting survey programs for new pest incursions at various spatial scales.

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**(17) Assessing the probability of freedom from pine wood nematode based on 19 years of surveys**

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Many quarantine pests, like the pine wood nematode (PWN) are surveyed annually in the EU. Still, the confidence in pest freedom achieved with the surveys is not commonly analyzed. We assessed the probability that Finland is free from PWN based on surveys done in 2000-2018. We used the methodology employed in the RiBESS tool, which has recently been recommended for quarantine pest applications. We studied two scenarios: 1) the surveys aimed to justify import requirements and to facilitate exports, and 2) the surveys aimed to detect invasions early to enable eradication of outbreaks. The surveys appeared to support the assumption that PWN is not present, but they did not seem extensive enough to ensure early detection. The sensitivity of the import-export surveys was over 0.6 in 11 years, while that of the early detection surveys was always below 0.4. For the import-export surveys, the probability of freedom by 2018 was at least 0.95 unless the mean time between invasions was less than 14 years. For the early detection surveys, it was at least 0.85 if the mean time between invasions was over 53 years. The confidence in pest freedom was probably overestimated, because the used methodology assumes that pest populations are not aggregated, although populations of invasive pests are typically aggregated. Furthermore, it assumes that pest prevalence increases only due pest introductions, not pest spread within the area. The gravity of these discrepancies should be evaluated to ensure that the risk management capacity of surveys is not overestimated.

**(18) Sequential sampling plan for a regional management control of Diaphorina citri in Persian lime: Citrus latifolia Tan. in Mexico.**

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For the management and control of the Asian Citrus Psyllid (*Diaphorina citri*), vector of the HLB, is necessary to implement a strategy of regional management and define if some measure of control is required. In this sense, the sequential sampling (SS) is the ideal tool to achieve these goals. To implement a SS, it is necessary to define: the statistical distribution that fits data, the type of spatial distribution, the possibility of using a common k (kc) and setting values decision thresholds. The data used in this study, correspond to records of the number of Psyllids caught weekly at each of the 1150 sticky yellow traps strategically located in plantations of the Persian lime in Veracruz, Mexico. It was found that population of Psyllids follows a negative binomial distribution; their spatial distribution is of the aggregate type and kc= 0.0522. The greater presence of plague arises from May to October due to incidence of rain and a strong tree sprouting. The threshold of decision to consider as high or low the Psyllid population is given by the equations: do >. 0576 * n + 2.5111 and do <. 0576 * n-2.5111 respectively. (n = number of traps). The maximum number of traps to make a decision is 60, a critical threshold corresponds to find 3 Psyllids in 10 traps and the probability of making a wrong decision is 5%. It is concluded that the SS is a powerful tool for effective regional control of this vector.

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**(19) Optimizing delimitation survey grids for insect pests**

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After detection of a new pest, the response team conducts a delimiting survey to determine the extent of the infestation in the United States. Following fruit fly examples, guidelines often default to recommending the use of a 5-by-5-mile trapping grid for insect delimitation surveys. However, little information is available for objectively designing delimiting surveys for specific scenarios. We used TrapGrid, a trap network model, to determine optimal grid and trap factors for delimitation trapping of insects with varied dispersal capabilities. We assessed trapping factors for insects with diffusion coefficients (dispersal capability, D, in $m^2$/day) between 5 and 50,000 based on representative species. We evaluated insect capture probabilities [p(capture)] at day 30 for various grid sizes (up to 12-miles-by-12-miles), shapes, and trap attractiveness values. Over different grid sizes, mean p(capture) was about

0.11 for D = 5, 0.23 for D = 50, and 0.35 - 0.37 for D = 500. To minimize the potential for insect escape from the grid, a size of 4-miles-by-4-miles was adequate for D = 500, 5-by-5 was fine for D = 5000, and 9-by-9 was needed for D = 50,000. Also, adopting a circular shape is recommended, as its performance was no different from a square but used 26 percent fewer traps. Finally, to achieve overall p(capture) = 0.5, suggested trap densities are 9 to 16 traps/mi$^2$ with very attractive traps, but 49 traps/mi$^2$ at p = 0.1, and 121+ traps/mi2 with p = 0.15.

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**(20) The potential economic loss of chili industry in China caused by *Bactrocera latifrons* (Hendel) based on @RISK**

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To predict the potential economic loss to chili chili industry caused by solanum fruit fly (*Bactrocera latifrons* Hendel), and provide scientific basis of prevention and control measures for related organizations. On the base of collecting related data of solanum fruit fly, price of chili in market and cost of prevention, we used the universal model of potential economic loss assessment of economically important fruit flies by Hongyu Sun, @RISK and stochastic simulation method, predicted the potential direct economic loss of chili industry caused by solanum fruit fly. With no control of the solanum fruit fly, we predict that the chili industry could lose 74.59-2 104.56 million dollars, but with effective control it would lose only 43.38-1 784.33 million dollars , a saving of 11.70-639.70 million dollars. The potential economic damage to the chili industry in China caused by the solanum fruit fly is high. Strengthening prevention and control of this pest is required to reduce rates of infection.

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**(21) Street palms and the potential impact of a palm pest on the USA mainland**

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The red palm weevil (*Rhynchophorus ferrugineus*) and the coconut rhinoceros beetle (*Oryctes rhinoceros*) are globally important pests of cultivated palms. Although these or any other palm pest would have limited impact to agriculture if established on the USA mainland, the impact in urban areas, where palms are commonly planted as street trees, could be significant. Unfortunately, urban areas are not inventoried systematically in the USA or elsewhere. To address this, we estimated street palm

counts for all populated places in 14 states (≈9400 communities) based on a limited number (N = 368) of existing street tree inventories. We used stochastic gradient boosting to estimate the palm proportion of each community's street tree population. In western states, this proportion was determined primarily by moisture regime, while in eastern states, the most influential factors were the frost-free period, winter minimum temperature, and coastal proximity. Socioeconomic factors (e.g., home value, poverty rate) were less important. Separately, we estimated average street tree density (trees / km of road) at a state or regional level based on refereed literature or our own geospatial analyses. We then combined the palm proportion and street tree density values with calculations of each community's total street length. Altogether, we estimate that there are roughly 4 million street palms on the USA mainland, with most in Florida (≈67%) or California (≈17%). Managing pest-affected street trees (including possible removal and replacement) can be costly, so a highly invasive palm pest could cause substantial economic damage, particularly in those states.

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**(22) The hemlock looper, *Lambdina fiscellaria* Guenée, 1857, and other threats to *Picea sitchensis* (Bong.) Carr. plantations in Europe via the horticultural trade**

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*Picea sitchensis* (Sitka spruce) is native to the Pacific Northwest of North America, and grown in Europe as a commercial forest tree, in particular in Ireland and the United Kingdom. *Picea sitchensis* has been transplanted to Europe without any of the major pests and diseases from its native range. Recognising the importance of *P. sitchensis* to the Irish economy, the Department of Agriculture, Food and the Marine funded the FORM project, which included a specific work package on threats to Irish *P. sitchensis* plantations. A pest list of species of *Picea* globally was compiled, and over 1300 pest and potential pest threats identified. As part of the project, a pathway PRA was carried out that looked at those pests which could enter the island of Ireland on plants for planting. This identified several pests who, though their main hosts were prohibited from being imported from outside of Europe by the current plant health regulations, had potential to enter on minor conifer species brought in for horticultural purposes. One example was the hemlock looper, *Lambdina fiscellaria*, a North American moth species whose caterpillars cause major defoliation of coniferous plantations during outbreak years. A rapid pest risk analysis was carried out, which identified fresh mosses and lichens, which are harvested from the forests of North America and exported to the EU, as an additional pathway of entry. The existence of this trade also raises the question of what other pests may be able to enter the EU on this currently unregulated pathway.

**(23) Black soldier fly *Hermetia illucens* (Diptera: Stratiomyidae) population dynamics model to explore waste management areas in Taiwan**

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As the global production of organic waste is alarmingly increasing in the form of agricultural and food wastes, is forcing the search of alternatives to reduce waste consequently Hermetia illucens is been a prominent biodegradation agent. With the aid of population modelling software DYMEX using previously published parameters and the application of two sex life table derived data from temperature transfers experiments. A population dynamic model was created. The model includes the predicted population behavior of *H. illucens*. Characterizing the likely population growth and development *H. illucens* will help to rapidly decompose organic waste and increase the mass production of *H. illucens* in Taiwan from five locations in Taiwan: Zhuzihu, Hualien, Sun Moon Lake, Chiayi, and Hengchun covering the range of conditions that *H. illucens* could be used as a waste management agent. In Taiwan. *H. illucens* outdoors population was predicted to decline and over-winter during the coolest months but populations during the warmer months will increase. The model predicted biomass production values at each site. The current model can be used as a tool in waste management, larva production and compost production.

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**(24) Risk management measures for fall armyworm (*Spodoptera frugiperda*) in Taiwan**

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The fall armyworm (*Spodoptera frugiperda*; FAW) has caused many severe agricultural crisis since its invasion of Africa in 2016 due to its high propagation ability. After 2018, the FAWs have invaded the Asia region and spread into many countries. In order to have early warning and detection their invasion, in April, Taiwan initiated public awareness program and established more than 500 monitoring traps at borders and cultivated areas of host plants in May 2019. Moreover, the import quarantine inspections for high risk products were strengthened at airports and seaports. In June 2019, FAWs were first discovered in Taiwan. To prevent the spread of FAWs and their wreaking havoc on crops such as maize, corresponding emergency actions were taken at different stages. The IPM includes the establishment of FAW field inspection-reporting-identification system, field sanitation, rotation with rice, scheduled pesticide sprays, sex pheromone monitoring and biological control by using natural enemies, all under

current development. The genetic structures of these FAWs are now being analyzed for clarifying the origins, biological characters and appropriate management measures of FAWs in Taiwan.

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**(25) Red Palm Weevil, *Rhynchophorus ferrugineus* records in Georgia and the innovative phytosanitary measures for eradication**

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The hazardous pest insect, red palm weevil, *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae) was first time observed on date palms (Genus: *Phoenix*) in spring 2009, in West Georgia Black sea resorts (Shekvetili, Guria). Before, *P. Canariensis* palms were intensively imported from Turkey. During the monitoring, strong spread of the pest was also found in palm root system. The second hub of pest distribution was observed to the coast line of Abkhazia, where the plants were severely damaged - out of the 20 damaged palms, 12 palms were completely destroyed. The potential area of pest spread is quite large, covers four regions (Adjara, Guria, Samegrelo, Abkhazia) of the country, tens of thousands palm trees are planted over the coastline, which increases the damage to the environment and economy. Preliminary quarantine measures - burning damaged plants, roots and destroying all pest instars in soil by beta-cyfluthrin 0.3% suspension were carried out immediately. The innovative approach was the mechanical control method; in particular, metal construction was installed individually to the infested palm trees and the insect proof nets wrapped metal branches until the weevils completed all instars, so they could not escape from the tree. The protective nets were treated periodically to destroy the emerging adults. Render innocuous palm trees were cutted down and exploded to avoid accidental distribution of the pest. Additionally, to use entomopathogenic nematodes (genus *Heterorhabditis* and *Steinernema*) are advised for the red palm weevil biological control. These biocontrol agents are considered as safe for environmental circumstances, human health and plant protection.

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**(26) Assessing the potential distribution of Asian gypsy moth in Canada: A comparison of two methodological approaches**

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Gypsy moth (*Lymantria dispar* L.) is one of the world's most hazardous invasive alien species. It is currently spreading across North America, damaging forest ecosystems and posing a significant economic threat. Two subspecies *L. d. asiatica* and *L. d. japonica* (collectively referred to as Asian gypsy

moth, AGM) are of special concern as they have several traits making them more potent invaders than their European counterpart (e.g. flight capability of females). Multiple detections of egg masses on vessels arriving from Asia have occurred in Canada and have led to the development of active phytosanitary measures. We assessed the potential distribution of AGM in Canada using two presence-only species distribution models (MaxEnt and GARP [Genetic Algorithm for Rule-set Prediction]). We mapped AGM potential future distribution under two climate change scenarios (A1B and A2) while implementing dispersal constraints using the cellular automation model MigClim. MaxEnt had higher AUC, pAUC and sensitivity scores (0.82/ 1.40/ 1.00) when compared to GARP (0.70/ 1.26/ 0.9), indicating better discrimination of suitable versus unsuitable areas for AGM. These model results can be used to identify areas at risk for this pest, to inform strategic and tactical pest management decisions.

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**(27) Predicting the spotted lanternfly dispersal in the United States**

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Spotted lanternfly (SLF), *Lycorma delicatula* (White) is native to southern China, Vietnam and India. It was first discovered in Berks County, Pennsylvania in 2014. It is currently occurring in Southeast Pennsylvania, Frederick County in Virginia, Warren, Mercer, and Hunterdon Counties in New Jersey, and New Castle County in Delaware. We have parameterized a spatially-explicit, discrete-time, stochastic, susceptible infected/infested (SI) model called PoPS (Pest or Plant Spread) to forecast potential spotted lantern fly spreads based on the SLF biology and detection locations. We then have integrated Tangible Landscape technology to simulate potential SLF dispersion by incorporating multiple management scenarios. Tangible Landscape is a novel modeling platform that allows users to guide complex geospatial models via physical interaction. Therefore, users can designate treatment zones on the physical representation of a landscape and incorporate them into the PoPS. The model projects results onto the landscape, allowing users to quickly and intuitively visualize how proposed management scenarios are likely to affect SLF distribution. These results are assisting APHIS PPQ make informed management decisions.

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**(28) A case study of Bemisia tabaci in north-west Europe and assessment of potential future establishment in the United Kingdom under climate change**

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*Bemisia tabaci* is an important agricultural pest of global significance primarily because of its ability to transmit multiple damaging plant viruses. To date, UK outbreaks of the whitefly have been restricted to glasshouses and there are no records of the whitefly establishing outdoors during the summer. This is despite the fact annual degree-day models (that estimate accumulated warmth over the year above the development threshold), indicate *B. tabaci* has the thermal potential for multiple summer generations in the UK. A set of 49 climate indices calculated using the present day climate were compared between the UK and the south of France, where *B. tabaci* is able to establish outdoors, to identify the factors limiting its establishment. The number of cold days and nights in summer, as well as the time spent within the whitefly's optimum temperature range, were most significantly different between the two areas. These indices may impact the development of *B. tabaci* and offer an explanation for the absence of the whitefly outdoors in the UK during the summer. Further analyses undertaken with climate projections suggest that in a 2-4°C warmer world this pest could pose a risk to outdoor UK crops in July and August. A clear south-north gradient can be demonstrated for these indices. Linking any possible northwards spread of *B. tabaci* populations outdoors in France with changes in these indices could therefore provide an important indicator of any change in the risks of outdoor populations of this species developing in the UK.

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**(29) Mapping and predicting the potential distribution of western flower thrips (*Frankliniella occidentalis* Pergande) in Taiwan**

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This report were aimed at predicting the potential distribution of western flower thrips (*Frankliniella occidentalis* (Pergande)) in Taiwan. To provide information for setting up survey spot and developing management strategy of western flower thrips. The Ecoclimatic Index ( EI ) of western flower thrips was analyzed by using CLIMEX model system. The results showed that there are 42 potential distribution areas of western flower thrips in Taiwan, which Ecoclimatic Index (EI) is more than 30, is very suitable for western flower thrips to survival. The highest risk area of western flower thrips occurred in Taiwan, including Taoyuan County, Ilan County, Hsinchu County, Taichung City, Nantou County, Chiayi County, Hualien County, Taitung County, such as altitude 700-2300 meters of pears, tea, cruciferous vegetables and melons areas of production. The results can be provided for forewarning epidemic situation to improve the efficiency of monitoring system of western flower thrips.

**(30) Potential distribution and impact of climate change scenarios on Fall armyworm, Spodoptera frugiperda in Asia with particular reference to India: Assessment through CLIMEX**

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The fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae), though an endemic and important agricultural pest in Americas, in 2016 entered African continent and the spread to several countries within a short period and reported in India (Asia) during 2018 causing several outbreaks resulting in extensive damage to maize and other crops. Being a polyphagous pest, though it prefers hosts from poaceae family, it also attacks other hosts from vegetables, flower crops etc. Insects, being poikilotherms are affected by climate factors, and climate change may affect geographical distribution, growth rate, abundance, survival, mortality, number of generations per year etc. These effects are projected for current potential distribution and future climate change scenarios for Asian continent with particular reference to India for the fall armyworm. The modelling was carried out using two general circulation models (GCMs), CSIRO Mk3.0 and MIROC-H, for 2030, 2050 and 2070 under the A2 Special Report on Emissions Scenarios (SRES), using the known distribution of the species and the CliMond meteorological database and CLIMEX, a bioclimatic software tool. Based on the Ecoclimatic Index (EI) values, the regions are divided into Unsuitable (0-5); Marginal (5.1-10); Suitable (10.1-15); Optimal (15.1-20) and Highly suitable (20 +). Similar identification of the regions with differential suitability was done with climate change scenarios also as mentioned above. The potential distribution of the pest depicts several regions in India and Asia as a whole are more suitable for the establishment of the pest. The possible number of generations was estimated to be more than 10 in some parts of India and other Asian countries as per the present/future climate change scenarios. With the climate change scenarios, the suitability of the pest is observed to be decreasing over the years in different parts of Asia. By 2070, 50-60 per cent of presently suitable area in India will be unsuitable for the pest. The futuristic climate change scenarios projected increases in the low-risk category of 20-30 % by 2070, compared with the current risk in different regions of Asia. Various implications of Fall armyworm incidence on different host plant ecosystems are discussed in this paper.

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**(31) Pest risk assessment techniques and climate change: Improving climate suitability for *Bemisia tabaci* in East and Central Africa correlates with increased prevalence of whiteflies and cassava diseases**

Darren J. Kriticos[1,2,3 *], Ross E. Darnell[4], Tania Yonow[1,3], Noboru Ota[5], Laura M. Boykin[6], Robert W. Sutherst[2 †], Hazel Parry[4], Habibu Mugerwa[7,8], M.N. Maruthi[8], Susan Seal[8], John Colvin[8], Sarina Macfadyen[1], Andrew Kalyebi[7], Andrew Hulthen[4] and Paul J. De Barro[4]

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Climate change analyses are becoming more commonly considered in pest risk assessments, as a means of ensuring that risk-management decisions are robust into the future. To come extent, these analyses are based on a leap of faith that they are valid. While the evidence for climate change as a whole is compelling, there have been few studies that have revealed fingerprints of climate change. In this paper we apply a CLIMEX model of the potential distribution of *Bemisia tabaci* to investigate the role of changing climate suitability in supporting a recent pandemic of begomoviruses in cassava in East and Central Africa. The CLIMEX model was correlated with independent observed field abundance of B. tabaci in the African study area, and we found that throughout the 33-year period of the study the climatic conditions for *B. tabaci* improved significantly in the areas where the pandemics were being reported, and were constant or decreased elsewhere. This is the first reported case where historical climate changes have been attributed to the increase in abundance of an insect pest, contributing to a crop disease pandemic. The detection of a climate change signal in this biophysical system should increase confidence in applying climate change scenarios to climatic niche models to identify potential future climate suitability patterns as a basis for devising robust climate adaptation strategies.

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**(32) Target population environments and pest distribution modelling: An approach towards pest prioritization and preparedness**

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The transboundary crop pest and disease (P&D) outbreaks over large geographical regions jeopardizes the food security and have broad economic, social and environmental impacts. The upsurge of new crop P&D, such as fall armyworm; cassava mosaic and brown streak virus; banana fusarium wilt tropical race 4 and wheat stem rust Ug99 are having serious repercussions on agriculture. Climate change is, in part, responsible for food chain catastrophes arising from these transboundary P&D. However, there is clear evidence that climate change impacts are altering the distribution of crop P&D. Such accelerated events require more attention on a greater scale to strengthen food security and protect the livelihoods of poor and most vulnerable countries of the world. A well-defined P&D ranking and distribution will focus on supporting policy-making, integrated P&D management as well as tangible pre-emptive breeding strategies at large scale. Here, we have used chickpea homogenous systems units (HSUs) defined by mechanistic models and geo-bio-physical parameters; over which the P&D distribution and rankings

were over-layered. The chickpea P&D severity, distributions, social impact and key drivers responsible for spread on these locations were identified by using meta-analysis. Further, in order to understand the possible risks and consequences of P&D population growth and geographical expansion, the CLIMEX package was used. We aim to compare the pest distribution generic models and prioritization methodologies for emerging regional specific P&D. These findings would support policy intrusions associated with long term transformative adaptation strategies for climate change.

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**(33) Potential geographical distribution of fall armyworm (*Spodoptera frugiperda*) in China**

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*Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), the fall armyworm, native to America, has invaded and spread throughout sub-Saharan Africa within two years. It has invaded China in the end of 2018, and spread to ten more provinces within five months. This study used two datasets of all distribution and year-round distribution worldwide of the fall armyworm respectively to predict its potential geographical distribution in China based on MaxEnt in order to offer the theory evidence to the related departments. The results showed that year-round surveillance should be done in Hainan, Yunnan, Guangxi, Guangdong, Fujian, Zhejiang, Jiangxi, Hunan, Guizhou, Sichuan, Chongqing, Hubei, Anhui, Jiangsu provinces, and seasonal surveillance in spring, summer and autumn should be done in Shandong, Henan, Hebei, Beijing, Tianjin, Shanxi, Shaanxi, Ningxia, Gansu, Qinghai, Inner Mongolia, Xinjiang and Liaoning. Further research of potential geographical distribution and potential economic loss are needed.

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**(34) Aligning incentives in import supply chains: a carrots and sticks approach**

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While a country's biosecurity status clearly relies on a deep understanding of how pests and diseases spread and respond to interventions, it should be recognised that pests and diseases are transmitted around the globe as a result of decisions made by humans. This means the way that humans respond to biosecurity rules must be explicitly considered if biosecurity objectives are to be met. A major challenge when designing incentive-compatible, strategy-proof biosecurity policy is to understand how stakeholders may respond to changes. A series of Australian government-initiated projects have been investigating the incentive effects that pre-border and border import rules have on the behaviour of stakeholders in import supply chains. While economic theory provides a useful foundation, designing

implementable incentives in the biosecurity context is complex and not well understood. Interviews with import supply chain participants, statistical analysis of inspection data, laboratory experiments and field trials have been used to assess and improve compliance with biosecurity objectives and improve system efficiency.

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**(35) A matter of survival: a simple model for the detection of an invasive species under surveillance**

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The impact of invasive species is affected by a range of factors, many of which can be anticipated in advance, for example, the prevalence of host material, likely climate suitability, pathways, the size of affected agriculture and so on. One key factor that cannot be anticipated in advance is the size of the incursion at the time of its detection, and, ultimately, the management response. The impact of an incursion is tightly tied to its maturity, ranging from a single gravid female, for example, to a 50,000 hectare infestation of gypsy moths. Furthermore, the maturity at the point of detection is affected by factors such as pest crypticity, surveillance effort, and so on. We propose a simple probability model for the detection of an invasive species that can reflect or integrate out the consequent uncertainty of the maturity of the incursion. We capture the relationship between surveillance and the detection of the organism using survival analysis: the detection of the incursion is analogous to the survival event; it is a binary occurrence that happens at some point in time, and once it has happened it does not happen again. Under such a model, we can easily connect the distribution of the size of the infestation at the time to detection to the probability of detecting the incursion given that it has not already been detected, namely, the hazard function. The hazard function has a known relationship with the time to event probability density function (pdf). Algebra leads us to a pdf for the time to event that is easy to compute but hard to write down. Other corrections are also applied as needed. The end result is a pdf that is a function of process parameters, enabling straightforward assessment of different surveillance choices. Parameter estimates for the distribution can be derived from first principles, field experiments, or expert elicitation. In this presentation we will demonstrate the use of the survival-based incursion size at detection pdf and its implications and challenges, and compare it with field data from several years of fruit fly incursions in South Australia.

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**(36) A multi-model approach to predicting emerald ash borer infestations**

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The emerald ash borer (EAB, *Agrilus planipennis* Fairmaire) is a non-native beetle to North America. First detected in 2002, EAB currently occurs in five Canadian provinces and 35 states in the United States, and has killed hundreds of millions of ash (*Fraxinus* spp.) trees causing severe economic impacts to individuals and government agencies. Rapid spread of EAB was aided by multiple factors notably human-mediated passive transport, active beetle dispersal, conducive climates, and a lack of efficacious natural enemies. Detection of start-up or endemic populations is hampered by cryptic nature of infestations that are often identified visually only after adults have emerged from an infested tree and due to non-intensive deployment of detection techniques. Predictive models could help in potentially identifying incipient EAB locations. The objective of this ongoing work was to develop correlative models for assessing the probability of occurrence of EAB populations at a fine spatial resolution. We superimposed a 1 sq. km hexagonal grid over EAB trapping locations in Canada (2002-2018) and calculated values of covariates relevant for predicting EAB infestations. These included topographical variables, road length, human population density, presence of campgrounds/parks, and meteorological variables. Weather-based variables were included because weather fluctuations could affect EAB development, and under extreme conditions (e.g., cold snaps), could cause mortality. We are using multiple approaches such as generalized linear models and classification-based methods to assess whether combining predictions from multiple models will result in greater predictive accuracy than single models. Results from this analysis will be the topic of this presentation.

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**(37) Influence of Methyl salicylate(MeSA) applied to eggplant on the behavior of *Thrips palmi* Karny (Thysanoptera: Thripidae) and its natural enemy *Orius strigicollis* Poppius (Hemiptera: Anthocoridae)**

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Eggplant [*Solanum melongena* L. (Solanaceae)] is one of the important vegetables in Taiwan. The most serious eggplant pest in Taiwan is the *Thrips palmi* Karny (Thysanoptera: Thripidae) that cause serious feeding damage to eggplants and also known to vector plant virus diseases, both of that always causing serious economic lost in Taiwan. Taiwan has a variety of native *Orius* spp (Hemiptera: Anthocoridae) that are good at preying on small pests such as thrips and spider mites. *Orius strigicollis* Poppius has the strongest activity and predation ability. This species has a very compacting effect on the *T. palmi*. There are many successful cases of release *O. strigicollis* applied to the field. But because in present the cost, technique and human resource that of rearing *O. strigicollis* still high, so we need to the extend working efficiency or value of *O. strigicollis* in the open field. Methyl salicylate (MeSA) a herbivore-induced plant volatiles (HIPVs), has been reported to be released from at least 13 crop plant species following attack by herbivores. MeSA is famous known that can elicit control of pests through attraction of beneficial arthropods. A previous study indicated that using MeSA in a juice grape vineyard, could attract O. tristicolor. Therefore, in this study we will using Y-tube olfactometer in the laboratory to investigate *T. palmi* & *O. strigicollis* responses after direct contact with odor from eggplant treated with the MeSA. Also to investigate will eggplant amplifies the herbivore-induced volatile response or not. We will be

conducting Headspace Volatile Collection of eggplant to investigate the volatile variation when eggplant exposure to synthetic MeSA. The aim of this study was to investigate were MeSA have potential to be a tool that can use to improve or solve the strategy of using *O. strigicollis* in biological control.

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**(38) Revisiting the use of Self-Organizing Maps (SOM) to predict to risk of invasion of re-emergent pest species**

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Self-Organizing Maps (SOMs) were first used by Susan Worner and Muriel Gevrey in 2006 to predict the risk of invasion of pre-emergent pest species using global presence/absence occurrence data. Over the past 13 years, a number of analyses have used this technique to predict pre-emergent invasive species either at a country or global level. However, the prioritized pest lists generated through SOM analyses are rarely being used by regulatory officials as a starting point to further refine the non-native pest universe to a more manageable list. This reduced and manageable pest list can be run through other high fidelity models for prioritizing the implementation of proactive monitoring programs and other preparedness activities. In this study, we perform SOM analysis on over 5800 invasive species distributed in 238 countries; this data set is much larger than used by other similar recent studies. We will present the results of the analysis of over 1.3 million presence/absence data points with risk rankings of potential invasive pests. Lastly, as part of Project Stinky, we will present the SOM risk ranking for *Halyomorpha halys* (Brown Marmorated Stink Bug) for those countries where this pest is currently absent.

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## Abstracts to Posters

### (Arranged in alphabetical order by the first author's last name)

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**Biology, bioclimatic modelling, and phytosanitary risk assessment of box tree moth, *Cydalima perspectalis* (Walker), in Canada.**

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*Cydalima perspectalis* (Walker), box tree moth, is an invasive pest species of boxwood, *Buxus* spp. It was detected in an urban neighbourhood in Toronto in August 2018 by a citizen scientist. This is the first confirmed report of this pest in North America. Box tree moth is native to Asia but has invaded many countries in Europe where it has caused severe damage to stands of boxwood, *Buxus* spp. It is believed to have arrived in Europe with a shipment of *Buxus* plants from Asia. In general, boxwoods are planted as ornamentals and typically used for edging, as hedges, and/or clipped into different shapes to make topiaries. No *Buxus* species are native to Canada, but *Buxus* cultivation and sales have increased rapidly in recent years, and sales to the United States represent a major part of the ornamental sector's economic value. A CLIMEX model available in the literature was modified to be suitable to the Canadian context: more realistic limits to survival in cold climates were added. Using both past and future expected climate normals strongly indicate that *C. perspectalis* can survive in the area of Canada from Toronto south. It may also be able to invade areas further north, to Montreal and North Bay. Future establishment in British Columbia and the Maritimes seems possible. With respect to its economic impact if it is able to enter Canada and become established, a preliminary assessment indicates that the absence of natural stands of *Buxus* plants in Canada would minimise the severity of the economic damage that this moth can cause.

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**Retrospective Analysis of PestLens Articles on Exotic Pests, 2008-2018**

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PestLens is a biosurveillance project for reporting on new, open-source material on plant pests exotic to the United States, and has been operating since 2007. We extracted and collated data from 1,925 PestLens articles posted from 2008-2018, and analyzed the data for meaningful trends and metrics. Our

data extraction process yielded information about pest genus and country of report for 1,618 records (84 percent). We analyzed monthly numbers of articles and six-month running means, over organisms, pest types, and geography. PestLens usually reported 10-14 total monthly articles, except for a sustained increase above 15 from 2017-2018. An average month had articles on six insects, two fungi, and one each of bacteria, nematodes, plants, and viruses. Fifty-four percent of articles referenced countries in Asia and Europe. Asian articles increased over time, especially for Eastern Asia. The annual number of unique genera reported upon increased significantly over time, while mean annual articles per genus decreased significantly. Together, these results indicated that the program reported on an increasing diversity of problem pests over time, rather than multiple articles about a few particular pests. We found examples (e.g., insects, fungi) where reporting spikes seemed to demonstrate punctuated periods of spread for specific organisms. Three-year periods with one or more consecutive articles seemed significant, as did five year periods with multiple, non-consecutive instances of two or more articles.

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**The RHS plant health strategy**

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The Royal Horticultural Society (RHS), is a UK based gardening charity with five UK gardens, annual flower shows and over half a million members. The RHS has a dedicated science team working on projects for the benefit of UK gardeners. Globalisation of trade and changes in climate are leading to an increase in pests and diseases being introduced to the UK, putting UK gardens and horticulture at risk. In response to this the RHS has expanded its plant health team and introduced a new plant health strategy to help protect the future of UK plant health. We provide a free advisory service for our members, which each year identified new pests and diseases in the UK, such as agapanthus gall midge, a species new to science, which was first found by the RHS in 2014. We are working across our gardens, shows and retail to look at reducing the risk of introducing new pests and diseases. This includes taking actions such as banning high risk hosts of *Xylella fastidiosa* unless they have been grown in the UK for 12 months or produced from seed in the UK, and carrying out higher intensity surveys and plant health checks at our RHS shows.

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**Screening potential pests of Nordic coniferous forests associated with trade of ornamental plants**

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Invasive pests cause extensive ecological and economic impacts worldwide and they are introduced into new areas especially via the international trade of living plants. We present a four-step screening procedure that was used to identify new potential pest risks of Scots pine and Norway spruce in Finland, Sweden and Norway that could 1) be introduced into the area at risk via the trade of ornamental plants, and 2) potentially fulfill the criteria to be regulated as quarantine pest in EU and Norway. In the first step of the process a list of all recorded pests of pine (*Pinus* spp.) and spruce (*Picea* spp.) was established using major pest databases. This list was then further screened to exclude pests that were considered irrelevant for the current work, e.g. pests that are already regulated. In the third step different types of rating criteria described in the EPPO's approach for commodity studies, but adapted to this work, were used to select the most threatening pests from the list. In the last step the FinnPRIO pest risk ranking model with a hypervolume approach was used to rank the selected pests according to their risk to Nordic coniferous forests. This work provides an extensive overview of the potential pest risks to Nordic coniferous forests that are associated with trade of ornamental plants, and the final rankings of the pests can be used by the risk managers to decide which pests or pathways to prioritize for conducting PRA's on to evaluate if new regulations are needed.

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**Application of a systematic methodology to create a pest list database for high risk plant commodities**

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To support the Commodity Risk Assessment procedure of high risk plants, plant products and other objects, as specified in Article 42 of the Regulation (EU) 2016/2031 on the protective measures against pests of plants, a specific evidence search strategy has been designed by EFSA to compile lists of pests associated with specific commodities. Following a pre-defined methodology, an extensive literature search has been carried out using online scientific databases (e.g. EPPO, CABI, ISI Web of Science) and other sources of technical and grey literature. The search syntax has been adapted according to the options and functionalities of the different database used and CABI keyword thesaurus. Search terms included common and scientific names for pests and diseases, terms describing symptoms of plant diseases and the scientific and common names of the commodity. The documents retrieved were screened on the basis of inclusion and exclusion criteria, and only the relevant ones retained for data extraction. All documents were stored in DistillerSR, a systematic review software, which was used to facilitate the process of data extraction. The collected relevant data needed to compile the specific pest lists were used for the creation of a comprehensive and harmonized database which will be kept updated.

**Performing an Expert Knowledge Elicitation (EKE) to estimate the likelihood of pest freedom for high risk plant commodities**

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In order to proceed with the export of commodities listed in the Commission Implementing Regulation (EU) 2018/2019, non-EU Countries are required to submit to the European Commission, a Technical Dossier to support the demand for import of high risk plants, plant products and other objects as specified in Regulation (EU) No 2016/2031. A commodity risk assessment is needed as a follow-up and is performed by the European Food Safety Authority (EFSA). Based on the evaluation of the Technical Dossier provided by the applicant country and following the risk assessment procedure, the relevant pests potentially associated with the commodity in the country of origin that may require risk mitigation measures are identified. Following this step, the overall efficacy of the proposed risk mitigation measures for each relevant pest is evaluated. For each relevant pest identified, the likelihood of pest freedom of a consignment is judged by experts in a structured way, called Expert Knowledge Elicitation (EKE). Here judgements are made in ranges (the credibility range covering 98% certainty, the interquartile range covering 50%, and the median estimate). Finally, the uncertainties associated with the judgement are quantified in a fitted probability distribution applying the methodology followed by EFSA when performing quantitative pest risk assessment. A conclusion on the pest-freedom status of the commodity for each of the relevant pests is agreed based also on the fitted probability distribution.

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**EPPO platform on Pest Risk Analysis**

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In September 2018, the European and Mediterranean Plant Protection Organization (EPPO) released the EPPO Platform on PRA (https://pra.eppo.int/). This platform aims to share information on activities on evaluation of pest risk in the EPPO region. It includes national PRAs produced by EPPO countries (e.g. Express PRAs, quick scans, interception PRAs, commodities PRAs) on different pests including invasive plants. They can be in any language. Countries may also share draft PRAs or plans for future PRAs. Most of the documents are publicly available but registered users may also choose to share documents to a defined group of users. The database is searchable, allowing the retrieval of PRAs for specific pests, countries, dates, etc. One year after its release, more than 700 documents are available through the Platform, including all PRAs produced by EPPO and the European Food Safety Authority (EFSA). Sixteen EPPO countries have created an account and started sharing their national PRAs. It should be noted that

users from all over the world are consulting the Platform. EPPO will discuss with other Regional Plant Protection Organizations during their next annual meeting the possible benefits of allowing non-EPPO countries to publish their PRAs on the Platform.

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**Inverse modelling of invasion risk for different invasion phases of forest tree pests in HOMED**

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Increasing trade and globalization as well as changing climates raise concerns for European forests that are threatened by exotic pest species. Assessing the risk of invasive species in early stages after detection requires data that is highly uncertain if available or based on expert elicitation. Therefore, the resulting pest risk assessments contain considerable uncertainty. In this work we will explore general drivers of past invasions and assess whether inverse modelling may be able to provide risk estimates of yet unknown species. A methodology using statistical and semi-mechanistic models on historical data on interceptions, establishments and spread combined with trade and environmental data is currently being developed. The use of a data-driven approach to predict risk is relatively novel, and will allow policy makers to make first-order estimates of risk given little information on the specific pest. Two examples of such an inverse modelling approach are presented. Major challenges lie in assembling the required data for the analysis. For example: data in Europe on pest occurrence is scattered and will need to be synthesized from a wide range of disparate sources. The resulting databases and models that predict establishment risk, establishment location, spread, and impact will be made available in an online platform.

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**Comparison of invasive pests in China and the United States**

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The development of global economic integration has created favorable conditions for biological invasion. Invasive pests have exerted great influences on economy, ecology and society. The investigation of invasive pests is one of the basic work to prevention and management. We used the global invasive species database (GISD) to collect information on the classification, origin, pathways and systems of invasive species in China and the United States, and supplemented it with the CABI database, Chinese or English books and literatures. Statistical analysis of the number and composition of species in the two countries showed that the number of invasive pests in the United States was higher than China. The source distribution pattern of invasive pests in each region was plotted according to the information of origin. By comparing the similarities of invasive species in pathways and systems, we found that the

main pathway was unintentional introduction, and terrestrial invasive pests were more dominant in invasion. We used the principal component analysis to find out the main factors affecting invasion. Through the integration of existing data, this study can further clarify the distribution pattern of invasive pests, explore the occurrence rules of invasive pests, and play a guiding role in the risk assessment of invasive species, early prediction design and rapid response plan among regions and countries in the future.

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**Potential geographical distribution prediction and overlap analysis of two invasive species - *Bactrocera dorsalis* (Hendel) and *Ceratitis capitata* (Wiedemann)**

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Studying spatial distribution and habitat overlap of important alien invasive species is vital for integrated pest management and ecosystem health. *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae) and *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae) are two main agricultural invasive insects, can respectively attack more than 250 and 400 vegetables and fruits causing huge economic loss. Thus, it is necessary to study the current and future global distribution characters of these two species. Based on the occurrence data, the oriental fruit fly, native to southeast Asia, has extended its range into seventy-four countries all of the world, mainly distributes in Africa and Asia. The medfly, native to tropical Africa, has invaded into ninety-two countries covered six continents, with wilder range than the oriental fruit fly. And in this study, CLIMEX and MaxEnt models were used to map the potential geographical distribution for these two species under current and future climate conditions. We compared the differences between the two models about the result of prediction, mainly focuses on the proportion of each climatic suitability (highly favorable, moderate, marginal, unsuitable). Meanwhile we analyzed the habitat overlap to find out the degree of niche overlap. Our research provided a reference for studying interspecific relationship and a guidance in management of these two species through analyzing spatial data.

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