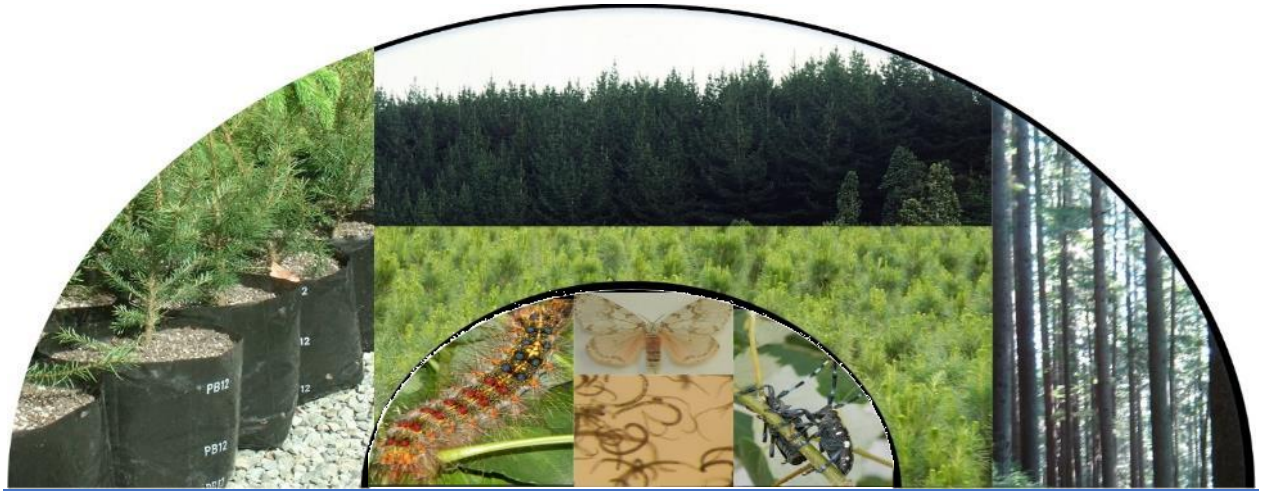

International Forestry Quarantine Research Group

International Meeting # 18

30 September – 21 October 2021

Proceedings of the Virtual Symposium

NOVEMBER 1, 2021

INTERNATIONAL FOREST QUARANTINE RESEARCH GROUP
SCIENCE STEERING COMMITTEE
https://www.ippc.int/en/external-cooperation/organizations-page-in-ipp/internationalforestryquarantineresearchgroup/

Disclaimer

The Mission of IFQRG

The mission of the International Forestry Quarantine Research Group (IFQRG) is to support and address critical forestry quarantine issues for the global plant health community through scientific analysis, discussion and collaborative research.

IFQRG is an independent, open international body providing scientific analysis and review of global forestry-related phytosanitary issues. The IFQRG serves as a forum for the discussion and clarification of key issues related to the phytosanitary implications of global trade with forest plants and products.

IFQRG's goal is for membership to include global representation from scientific, industrial and phytosanitary organizations from both developed and developing nations. Membership is open to suitably qualified individuals who have demonstrated expertise in disciplines relevant to plant health. IFQRG endeavors to recruit members from all FAO regions.

To become a member of IFQRG, the individual submits a short biography or curriculum vitae to the Science Steering Committee (SSC) outlining research or other relevant experience. Membership applications will be accepted by the SSC if information on the applicant indicates they would be a suitable member of IFQRG. There is no membership fee.

Symposium Proceedings

These proceedings communicate the discussions and conclusions from the 2021 International symposium number 18 of the International Forestry Quarantine Research Group. The symposium was held on-line (virtually) on the 30th September, and the 7th, 14th, and 21st October, 2021.

Recommended citation:

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List of Abbreviations

ALSC	American Lumber Standards Committee
APPPC	Asia Pacific Plant Protection Commission
CFIA	Canadian Food Inspection Agency
CLSAB	Canadian Lumber Standards Accreditation Board
CPM	IPPC Commission on Phytosanitary Measures
CRADA	Cooperative research and development agreement
CWPCA	Canadian Wood Pallet and Container Association
DH	Dielectric Heating
EAB	Emerald Ash Borer (*Agrilus planipennis*)
EDN™	Ethanedinitrile (C_2N_2)
EPPO	European Plant Protection Organisation
FPSA	Forest Products System Approach
HACCP	Hazard Analysis and Critical Control Points
HT	Heat Treatment
IFC	IPPC Implementation and Facilitation Committee
IFQRG	International Forestry Quarantine Research Group
IFU	Implementation and Facilitation Unit
IPPC	International Plant Protection Convention
IPRRG	International Pest Risk Research Group
IRSS	Implementation Review and Support System
ISPM	International Standards for Phytosanitary Measures
ISPM15	ISPM No. 15 *Regulation of wood packaging material in international trade*
ISPM28	ISPM No. 28 *Phytosanitary treatments for regulated pests*
ISPM42	ISPM No. 42 *Requirements for the use of Temperature Treatment as Phytosanitary Measures*
IUFRO	International Union of Forestry Research Organizations
IYPH	International Year of Plant Health
MBr	Methyl bromide
MW	Microwave
NAPPO	North American Plant Protection Organization
NEPPO	Near East Plant Protection Organization
NGS	Next Generation Sequencing
NPPO	National Plant Protection Organisation
OECD	Organisation for Economic Co-operation and Development
OTUs	Operational taxonomic units
PCE	Phytosanitary Capacity Evaluation
PMRG	Phytosanitary Measures Research Group

PWN	Pine Wood Nematode (*Bursaphelenchus xylophilus*)
RoP	Rules of Procedure
RPPO	Regional Plant Protection Organisation
SC	IPPC Standards Committee
SSC	IFQRG Science Steering Committee
STDF	Standards and Trade Development Facility
ToR	Terms of Reference
TPFQ	IPPC Technical Panel for Forest Quarantine
TPPT	IPPC Technical Panel for Phytosanitary Treatments
USDA-APHIS	United States Department of Agriculture- Animal and Plant Health Inspection

MEETING REPORT

1. Welcome Address

The meeting of IFQRG 18 was hosted online by Natural Resources Canada, Canadian Forest Service. Forests and their sustainable management all over the world have presented researchers with many challenges during the past decades. Responses with solutions were and are being only possible because of scientific cooperation among institutions and their dedicated scientists.

2. Opening of the meeting

IFQRG Chair, Dr. Michael Ormsby, opened the meeting and welcomed all participants.

3. Introductions

A list of the recorded participants is provided in Appendix 1.

4. Symposium Agenda

Page No.

5. Presentation Abstracts

Day 1 – September 30: PEST MITIGATION AND UPDATES

1.1 Greetings & Introduction to IFQRG Ormsby/ Allen

IFQRG Introductory Remarks

Author: Eric Allen

Presenter Bio: Dr. Eric Allen, now retired, was head of the Forest Invasive Alien Team with the Canadian Forest Service at the Pacific Forestry Centre in Victoria, Canada for more than 20 years. He worked extensively on non-indigenous species that impact forest ecosystems; their biologies, their movement with international trade, and the assessment of mitigation measures. During his career, he was the founder and chair of the International Forestry Quarantine Research Group (IFQRG), and member of the North American Plant Protection Organization (NAPPO) expert group on forestry systems approaches and the International Plant Protection Convention (IPPC) Technical Panel on Forest Quarantine. Through these fora he has supported the creation of a number of regional and international standards for phytosanitary measures and guidance documents for both and has recognized the importance of team work and collaboration through bringing global experts from science, industry and regulatory communities together to solve phytosanitary issues in forestry.

Purpose: To give an historical overview of the International Forestry Quarantine Research Group

The International Forestry Quarantine Research Group, created in 2003, had its first meeting in Rome in February 2004. Since then 14 meetings have been held, many in Rome, but also in Canada, Portugal, Australia, Wales, China, New Zealand and Brazil. This year because of COVID19 the meeting was held online. A key client of the IFQRG is the Commission of Phytosanitary Measures (CPM) and its subsidiary bodies: technical panels, expert working groups, regional and national plant protection organizations. The relationship among these bodies is evolving, in particular the need for specific questions raised by the Standards Committee or the TPFQ to be addressed. This helps refine the role of IFQRG to bring together all available information on a particular topic and to provide a response based on the best available information. IFQRG has, through analysis and specially focused research, provided the scientific background necessary for the ongoing refinement of ISPM 15 e.g. re-infestation studies, recommendation of bark tolerances, and publication of new perspectives on treatment efficacy – probit-9. The original vision of IFQRG was to pursue collaborative scientific activities, to foster a culture of respect and cooperation among the members. Although open debate is encouraged, this should not be a stage for political messaging or advocacy of national policies. Finding solutions to reduce the international movement of forest pests, in many cases this means looking beyond the borders of our own countries or regions; it means considering the issues and challenges of all countries whether developed or developing. IFQRG has a wide diversity of background, expertise and experience, comprising predominantly scientists, working in government institutions, universities, and industry labs as well as plant protection experts and industry leaders. Participants are encouraged to join as critical thinkers, ready to share knowledge and expertise, but to leave “positions” at the door. Since its

inception in 2003, IFQRG has matured and its role and relationship with other groups. It has been increasingly clear that the most useful function of the group as a partner in advancing forest phytosanitary issues is providing science and interpretation of science. To this end, more scientists from developing and developed countries are needed to participate in IFQRG activities.

Session Moderator: Adnan Uzunovic

Bio: Adnan Uzunovic was a senior research scientist for over 20 years at FPInnovations (Canadian Wood research institute), working on wood protection from pests that cause deterioration or market issues, developing various test methodologies, conducting research on the management of wood pests, and participating in different national and international forums. Adnan has been member of IFQRG since its establishment and other relevant groups serving various functions in support of IPPC phytosanitary standards development and their implementation, and a member of the International Group of Wood preservation. Currently Adnan provides scientific advice and representation to Canada Wood to support regulation and biosecurity of wood products exports and imports.

1.2 Progress update for radio frequency heat treatment for wood Phyto-sanitization GAGNON

Authors: Gagnon, M.A., Hoover, K., Szymona, K., Janowiak, J. and Mack, R.

Presenter bio: Mark Gagnon is the Harbaugh Entrepreneur and Innovation Faculty Scholar, Associate Teaching Professor of Agribusiness and Director of The Food and Bio-innovation Entrepreneurship Minor in The College of Agricultural Sciences at Penn State. Mark is a former entrepreneur and business development executive. He has participated in several start-ups and has been involved in corporate business development in building products. He co-founded The Entrepreneurship and Innovation Program in The College of Agricultural Sciences at Penn State University. Mark's scholarly interests are within entrepreneurship that address challenges in food, agriculture and bio-renewables (Food-Agri-Tech). His current research examines new technology value proposition development and strategic implementation.

Abstract: Radio frequency heat treatment (RFHT) of wood packaging material continues to demonstrate promise for the phyto-sanitization of wood pallets and packaging. The incorporation of second-generation RF technology and its anticipated wood packaging material HT improvements will be discussed together with the commercial potential for the energy saving design. The team will update their progress on standard RFHT operational protocols and agency review.

Participant questions:
Comment: How to advance work now? Could be good at ports with supply of salt water (ocean), also good for dunnage.

1.3 Kiln heating of *Metrosideros polymorpha* roundwood to eradicate rapid `ohi`a death (ROD) fungal pathogens HUGHES

Author: Marc Hughes, Pacific Cooperative Studies Unit, University of Hawaii at Manoa, Hilo, HI

Presenter bio: Marc Hughes received his PhD in plant pathology at the University of Florida (USA) and is currently a forest pathologist working with the University of Hawaii at Manoa and the USDA Forest Service in Hilo, Hawaii. His work focuses on the biology and management strategies of Rapid Ohia Death,

a lethal and expanding disease of the Hawaiian keystone tree species, *Metrosideros polymorpha* (ohia lehua tree).

Purpose: To report the results of two trials testing the ability of dehumidification and vacuum kiln heat treatments to eradicate the causal agents of rapid `ohi`a death (ROD) in colonized host logs

Abstract: Two kiln heating treatment methods were tested to eradicate the ROD fungal pathogens *Ceratocystis lukuohia* and *C. huliohia* in diseased `ohi`a roundwood with bark removed. In the dehumidification kiln trials, small-diameter (8.0 cm), infested poles were heated to a core wood target temperature of 60° C over several weeks. Larger diameter ohia poles (23 cm) were treated in a vacuum kiln over 2 to 4 ½ days. Logs were subjected to a 56° C threshold temperature at a 70% log radius targeted depth and held for 30 minutes. For both trials, fungal viability was assessed by carrot baiting wood subsamples from sampled disks of pre and post heat treatment logs. Both treatment protocols completely eradicated *Ceratocystis* in diseased `ohi`a logs.

Participant questions:
Q: Concerning the international movement of these *Ceratocystis* pathogens, would you consider wood products to be a pathway? Or would the main pathway be plants for planting?
A: I think for ohia in Hawaii wood would be a "better" pathway of spread as small plant material does not get infected often and it is not considered a nursery disease.
Q: The question regarding the Ohia treatments was about the correlation of moisture reduction and heat. Have there been any studies that focus solely on how the fungi react to kiln drying only? Is it known at what point during the extended commercial treatment that mortality occurred? Could the drying of the wood also be contributing to the efficacy of treatment?
A: This was the first set of studies for this plant-pathogen system. We have not looked into the effects of drying only. For the dehumidification kiln run (28-33 days) fungal viability was only assessed at the end of the experiment. The Vacuum kiln trials were much faster (1-4 days). Wood drying could contribute to fungal death. I think wood moisture content plays a role in establishing initial wood colonization and fungal survival, just haven't tested it yet.
Comment: During the drying process, it is heat that kill the fungi rather than lowering moisture content. Desiccation may be lethal to fungi, but it will take very long time in a low humidity environment.
Comment: If you're interested, we [Meghan Noseworthy] could look at lower temperatures. We use a hot water bath with inoculated barley grains to test the range of heat treatments. We've done quite a few wood pathogens and are building a list of lower thresholds.

1.4 Research and registration update on EDN™ as a postharvest treatment for forest products SWAMINATHAN

Author: Dr Swaminathan

Presenter bio: Dr Swaminathan is working as the Head of Research and Regulatory Affairs with the Draslovka Services group based in Sydney, Australia. He is involved in the registration and biosecurity approval of EDN, Bluefume and eFume products globally. He was responsible for getting the world's first EDN registration for timber and soil in Australia. He completed a PhD in Agriculture with specialisation in Entomology.

Purpose: The purpose of this presentation is to provide an update to the IFQRG group on EDN™ work for treatment of forest products.

Abstract: EDN™ has been identified as a potential alternative to methyl bromide fumigation for the treatment of forest products. It is registered in Australia, Malaysia, Russia, South Korea, and the Czech Republic (under permit). Registration is expected this year in New Zealand. Registration is in process in the USA, EU, Israel, South Africa, Turkey, Egypt, Philippines, Thailand, Indonesia and Vietnam. Recent efficacy studies have shown that EDN™ is very effective on NZ timber pests and pinewood nematode in logs and wood chips.

Participant questions:
Q: IFQRG has played a significant role in providing science support treatment guidance for the revision of ISPM. EDN approval under ISPM-28 and 15 can only be submitted by NPPO members. We have been working with an NPPO, but they are very slow or not responsive. So, there is no progress. Instead of NPPO, can Draslovka directly submit the supporting documents to gain approval under ISPM-28 & 15?
A: No, as stated submissions must come from contacting parties (NPPOs or RPPOs). A private company could draft the submission on behalf of a contacting party.
Q: How could IFQRG support Draslovka to gain approval under ISPM-28 & 15?
Comment: This demonstrates the hurdles to getting new treatments widely accepted and approved for use internationally and includes providing efficacy data to satisfy international phytosanitary community as well as various environmental protection agencies in individual countries to register new chemical active. Ideally, we all could try to assist in speeding up the process for promising treatments in efforts to effectively manage pests in trade and reduce burden to companies that carry the work. The key question is how?

1.5 *Bretziella fagacearum* in Quercus alba logs: Vacuum steam treatment, pathogen viability, and implications for European risk assessment YANG

Author: Anna Yang

Presenter bio: Anna Yang is a Pathways Intern with the Northern Research Station, U.S. Forest Service and a Ph.D. student at the University of Minnesota in St. Paul, MN. She has conducted research related to the detection and management of oak wilt since 2011. Since 2016, she has worked on several phytosanitary trails evaluating alternatives to methyl bromide treatment of oak and walnut logs. Anna has a B.S. in Plant Biology and M.S. in Plant Pathology (University of Minnesota).

Abstract: Logs and main stem disks obtained from *Quercus alba* trees infected with *Bretziella fagacearum*, the fungal pathogen that causes oak wilt, were used in complementary studies to 1) evaluate the ability of vacuum steam (VS) treatment to eradicate the pathogen from logs and 2)

characterize the spatial distribution and viability of the fungus disks taken at 1.8 m intervals between logs harvested for the VS study. Trees were artificially inoculated with the pathogen in June 2019, exhibited localized crown wilt symptoms in 2019 and 2020, and were harvested in late October 2020. For the VS study, five replicate trials with three logs per load were conducted in a portable chamber to test two VS treatment schedules: 60° C for 60 minutes and 56° C for 30 minutes. No viable *B. fagacearum* was found in logs following either VS treatment schedules at 5 cm targeted depth below the bark furrow; the pathogen was isolated from only 0.63% of pre-treatment sapwood samples (n = 792 assayed samples). In the colonization study, *B. fagacearum* was isolated from 2.7% of sapwood samples (n = 110 assayed samples), while pathogen DNA was detected in 60% of sapwood samples taken from the same locations. The very low levels of viable pathogen in logs and disks of these studies suggest that previous year infections, often bounded by clear tissue of the current year growth increment, would not be a source of inoculum for bark or wood-boring insects.

Participant questions:

Q: For *Ceratitis*, was 56/30 just as effective as 60/60?

A: Hard to say as due to low pre-treatment viability. More work needed in white oak, but fine in red oak. Canada have looked at heat in-vitro (water bath) and found 48 C is effective. Pathogen is very suspectable to heat and drying.

Q: In the absence of vectors (i.e. no bark), there any evidence that this pathogen can move from infected wood/logs to suitable hosts?

A: I agree! Without a vector, I don't think we have any reason to believe that infected white oak logs could move to other oak hosts. The pathogen is highly dependent on insect vectors to move spores from infected logs, so there is little/no risk of other pathways (such as airborne spores).

Q: Great presentation Anna! Very interesting to see those low pre-treatment levels of recovery in white oaks, a testament to its ability to compartmentalize the fungus.

A: Conceptually connecting this work to standing diseased white oaks is also really interesting. It seems like very little of the pathogen is able to escape compartmentalization, which explains why diseased white oaks exhibit dieback in a somewhat unpredictable manner.

Comment: Well, that seems to be true on the first look. We need to take into account the residues that occur in the sawmill/veneer mill in the EU during processing the logs. The same assumption (no transmission is possible without the vector) was made with PWN. But we were able to prove that transmission via wood chips even in the absence of the vector works pretty well. So one needs to take into account the handling and use at the place of Destination as well.

Comment: Wonderful experimental work Anna, thanks for presenting! It would be interesting to test more isolates of *B. fagacearum* in vitro in our [Meghan Noseworthy] hot water bath if you are interested. As I mentioned our team at the Pacific Forestry Centre (CFS) in collaboration with FPInnovations have tested three isolates recently and shown that *B. fagacearum* does not survive 42°C/30min. Great to show both dose and delivery effectiveness.

Comment: Thank you! What type of material are you treating? Treating other isolates could be valuable, thought the genetic diversity of *B. fagacearum* is considered to be very low, so I'm not sure that you would expect different responses based on different isolates. But then again, that work was done using RFLPs in the 1990s and is perhaps a little dated now.

Comment: We [Meghan Noseworthy] inoculate barley grains and treat them in sealed glass vials with high precision control (so as to not overshoot the target temp). We've seen slight differences between isolates of *Phytophthora ramorum* but not the three isolates of *B. fagacearum* which we tested.

Comment: Interesting! It could be worthwhile to test different isolates, especially isolates from states that export a significant amount of oak

Comment: Good point, this is something we're concerned about in Canada. Not an issue yet but we do import logs from the US for processing and export!

1.6 Australia's invasive forest insects: arrivals vs establishments NAHRUNG

Author: Helen Nahrung

Presenter Bio: Dr Helen Nahrung is a Senior Research Fellow at USC's Forest Research Institute, working in partnership with the Department of Agriculture and Fisheries. She holds an Advance Queensland Fellowship on forest insect invasions, is President of the Entomological Society of Queensland, and Deputy Chair of the national Forest Health and Biosecurity Sub-committee of the Australian Forest Products Association. Her research focuses on understanding insect invasion processes towards their prevention and management: invasive insects cause severe economic and environmental impacts globally, moving accidentally via trade and travel.

Purpose: To describe the historical accumulation of non-native forest insects in Australia, with a focus on their border interceptions that might inform pathway management.

Abstract: Since the late 1880s Australia has accumulated around 140 non-native insects in its plantation, amenity and native forests. We review these historical arrivals and link them with border interception frequencies, biological traits, commodities and countries of origin. Recent arrivals are described in terms of their predictability, interceptions, and how they were first detected after establishment.

Participant questions:
Q: I would be very interested in understanding the relationship of risk between arrival (interception) and establishment. Is this something that IFQRG can dig into further?
A: Papers to read on interceptions: Bonnamour et al. (2021) Insect and plant invasions follow two waves of globalisation. Ecological Letters; Liebhold et al. (2021) Invasion disharmony in the global biogeography of native and non-native beetle species. Diversity and Distributions.
Q: I [Marcel Dawson] would be interested in receiving data, especially pathways of interception? Also, for wood packaging any differentiation between dunnage and other WPM, e.g., pallets?
Comment: Further questions can be directed to Dr. Helen Nahrung (Forest Health at the University of the Sunshine Coast, Australia) hnahrung@usc.edu.au

1.7 The good and bad of alternative wood treatments GLASSEY

Author: Ken Glassey

Presenter bio: MPI Ken Glassey works on the treatments team of NZ Biosecurity and is a member of the Methyl Bromide Technical Options Committee that reports to Parties of the Montreal Protocol.

Purpose: To give an overview of a range of possible phytosanitary treatments for wood.

Abstract: Replacing the big bad (is it that bad?) methyl bromide is a problem so what are the options? A quick overview of the good and bad of some alternatives such as controlled atmosphere, bark removal, ethanedinitrile (EDN™), hydrogen cyanide (HCN), phosphine, sulfuryl fluoride and temperature. Would ethyl formate work and, ever heard of cold plasma?

Participant questions:
Q: What gas is used as Cold Gas method?
A: Generally, Cold plasma treatments use humid air input and changes the nature of the air (atmosphere) you have. Plasma is a quasi-neutral gas. Matter on earth exists mostly in three distinct

phases (gas, liquid and solid) but when the universe is considered as the fourth state of matter which abundantly exists. So, Plasma is hence referred to as the fourth state of matter, next to solids, liquids and gases. It contains free electrons, ions and neutral particles and more than 99% of the visible matter in the universe are in the plasma state. It is a mixture of an electrified gas with chemically reactive compounds that consists of ions, free electron, activated and metastable species

1.8 Summary, additional questions and discussion Ormsby/ Nehme

Nature conservancy looking to do research on surveying particular pathways for interceptions (e.g. what are the risky pathways and what is moving in trade?). We have the ability to test in-vitro heat tolerance of pests - value of determining actual naked tolerance of pests to separate this from operational issues of applying the treatment.

Day 2 – October 7: ISPM 15 – GUIDANCE AND REVIEWS

2.1 Greetings & Introduction to IFQRG Ormsby/ Allen

Session Moderator: Dr. Thomas Schröder

Bio: Dr. Thomas Schröder is a forest scientist. He has over 20 years of research experience in forest quarantine, including as head of the forest quarantine laboratory of the Institute for National and International Affairs of the Federal Research Institute JKI in Braunschweig/Germany. Thomas has been working in the IFQRG since its foundation. In relation to ISPM 15, he served on the IPPC Technical Panel on Forestry Quarantine (TPFQ) from its inception until 2016. Among other things, the TPFQ was active in the revision of ISPM 15 and drafting other forestry related ISPMs. He also authored the Guidance Document on the Implementation of ISPM 15 in Germany and is co-author of the IPPC Guidance Document on ISPM 15. Currently, Thomas is a Senior Officer in the Plant Health Unit of the Federal Ministry of Food and Agriculture in Germany.

2.2 ISPM 15 and wood treatments: an update from the International Plant Protection Convention (IPPC) Secretariat PETERSON & KISS

Authors: Barbara Peterson and Janka Kiss

Presenter's bio:

Janka Kiss is a Standard Setting Associate at the IPPC Secretariat. She is mostly working with the Technical Panel on Phytosanitary Treatments since 2016 and holds a degree in plant protection engineering and horticulture. She is working with the Standard Setting Unit since 2016 supporting the Standards Committee's work and coordinating expert input to drafting ISPMs and phytosanitary treatments.

Barbara Peterson is a Canadian Food Inspection Agency Official who is on loan to the International Plant Protection Convention (IPPC) Secretariat. She has been working with the Implementation and Facilitation Unit since April 2019. Barbara's main areas of responsibility include coordinating the IPPC's work on e-Commerce and managing the development of IPPC Guides and training materials. She is also responsible for facilitating the development of an IPPC Guide to support the implementation of ISPM 15.

Purpose: The purpose of the presentation is to provide IFQRG members with an update on IPPC activities related to ISPM 15

Abstract: This presentation will provide an update on recent CPM Standards Committee discussions and decisions related to ISPM 15 and wood packaging treatments, as well as an overview of the status and next steps in the development of the IPPC Guide to support implementation of ISPM 15.

Participant questions:
Comment: New ISPM 15 treatment would need a submission of a topic at a call (after ISPM 28 approval) then an EWG would amend ISPM 15.

2.3 Criteria for developing treatments for wood packaging material in international trade ORMSBY

Author: Dr Mike Ormsby

Presenter bio: Dr Mike Ormsby manages a team of scientists in the New Zealand Ministry of Primary Industries that assesses pest risks to New Zealand and oversees research programmes to support pest management. Dr Ormsby has worked in the phytosanitary area for over 24 years and has been a member of IFQRG and the IPPC technical panels for treatments and forest quarantine since 2005.

Purpose: Describe criteria that IFQRG has constructed to promote the development of new phytosanitary treatments for wood packaging material

Abstract: IFQRG, in support of what was the International Plant Protection Commission (IPPC) Technical Panel for Forest Quarantine, developed a set of criteria for the development and approval of treatments for use in the International Standard for Phytosanitary Measures (ISPM) number 15: *Requirements for Wood Packaging Material in International Trade*. In this presentation, I will summarise the criteria that have been developed and provide the justification for each aspect of the proposed criteria. The criteria describe a number of steps the lead treatment developers through a process that culminates in confirmatory trials on a single easily accessible wood pest.

Participant questions:
Comment: Discussed issues such as approval process, and criteria approval process.

2.4 Innovative Temperature Monitoring for Alternative Heat Treatment Technologies of WPM and Logs HEFFERNAN & MACK

Authors: Bill Heffernan, Electric Power Engineering Centre/ University of Canterbury, Christchurch, NZ/ Email: bill.heffernan@epecentre.ac.nz; John Janowiak, Kelli Hoover, Karolina Syzmona/ Penn State University/ University Park, PA 16802 USA, Ron Mack, Commodity Treatment Specialist/ USDA-APHIS-PPQ, Buzzards Bay, MA, USA

Presenters' bios:
Bill Heffernan received his B.Sc. (Hons) in Electrical Engineering from the University of Manchester, U.K., in 1984 and his Ph.D. from Birmingham University, U.K., in 1995. A U.K. Chartered Engineer and member of the IET and IEEE, he is currently senior research engineer with the Electric Power Engineering Centre (EPECentre) at the University of Canterbury, New Zealand. His professional interests include electric power applications, power electronics, magnetics and instrumentation. With the team at the EPE Centre, he has been applying electrical engineering to heating logs, with support from NZ industry and government, since 2007.

Ron Mack is a Commodity Treatment Specialist with USDA-APHIS-PPQ S&T, where he has broad responsibility for treatment development with particular focus on wood. Research interests include new technology development and industrial processes as they relate to commercialization. Ron has been a long-term member and contributor to the International Forest Quarantine Research Group (IFQRG) and has more recently been involved with projects to support NAPPO. He received a bachelor's degree in Wildlife Management and a master's degree in Entomology, both from the University of Maine.

Purpose: To inform colleagues on the development status of alternative heating technologies used on wood and highlight temperature monitoring strategies used to improve operational efficiency leading up to potential commercial application.

Abstract: Alternative treatments for heating commercially important wood commodities, namely solid wood packing material (SWPM) and logs, were examined to determine the effectiveness of temperature monitoring strategies used in process control. Dielectric heating of SWPM components using radiofrequency (RF) and Joule heating of unseasoned logs both offer tremendous reductions in overall treatment time when compared to conventional heating, with each process optimized through careful consideration of heat, mass, moisture content and electrical transfer within the timber. Differences exist, however, in the approach to effective temperature monitoring to achieve successful phytosanitary treatment objectives. Dielectric heating (RF) of SWPM, a treatment method approved by the Commission on Phytosanitary Measures (CPM) of the IPPC for ISPM-15 compliance, requires establishment of a reliable and efficient procedure for monitoring temperature in SWPM treated workloads. Reliability, ease of use, and replacement convenience are necessary to provide practical solutions that are easily applied in the pallet treatment industry. To that end, low cost, pop-up thermal indicators embedded in the workload were combined with thermal imaging to provide sufficient evidence post-treatment that phytosanitary treatment temperature objectives were reached. Recent development of smart electrodes for use in Joule heating application on *Radiata pine* logs has allowed for accurate measure of the spatial current density flowing in the log ends, providing a map of electrical conductance across the log face. This map can be used to discriminate between the heartwood and sapwood portions of the log, enabling accurate estimation of the required thermal energy to heat the log to a given temperature. Since the longitudinal electrical conductivity of the sapwood in unseasoned logs is directly proportional to temperature, the radial distribution of heat and the temperature rise throughout the log can be accurately estimated by the ratio of hot to cold conductance, regardless of the heat treatment method.

Participant questions:
Comment: Discussion on the use of pop-up temperature probes (turkey probes) as an inexpensive but surprisingly accurate way of monitoring internal temperature thresholds.

2.5 Wood Pallet Industry Perspective: Moving Toward Continuous Improvement of ISPM 15 GETHING

Authors: Brad Gething, Scott Geffros, Marcel Dawson and Eric Allen

Presenter bio: Brad Gething, PhD, is the Vice President of Science & Technology for the National Wooden Pallet & Container Association. Brad works with wood pallet standards, initiates and oversees industry research projects, and serves as lead point of contact for PDS™ pallet design support and education. He has been a member of IFQRG for over 10 years, dating back to his work as a graduate assistant helping to develop DH heat treatment schedules for ISPM 15. Brad earned a MS and PhD degree in Materials from Penn State University, and a BS degree in chemical engineering from Bucknell University.

Purpose: Provide IFQRG with an industry perspective on the challenges that exist in identifying the best path forward to help improve ISPM 15 compliance.

Abstract: The wood packaging industry relies on ISPM 15 to effectively mitigate the spread of invasive pests and facilitate safe trade with wood packaging. Although ISPM 15 has been shown to be very effective in reducing associated pest movement in wood packaging used for international trade, pest

interceptions still occur and have been cited as a failure of the program. While interceptions are a concern, they need to be considered in the context of the potential of the pests to establish. Industry desires to seek opportunities for continuous improvement but is challenged to identify the areas of greatest risk. This presentation will pose the following questions to IFQRG members: How is pest risk best determined, what are the areas of greatest risk, and how might that risk best be mitigated?

Participant questions:
Comment: Can put international meetings together to discuss ISPM 15 issues.

2.6 What and where are the weak links? Exploring pest mitigation research and management associated with the solid wood packaging supply chain in North America GREENWOOD

Authors: Leigh Greenwood, David Coyle, Chris MacQuarrie and Meghan Noseworthy

Presenter Bio: Leigh Greenwood is the Forest Health Program Director for The Nature Conservancy. Her work focuses on bringing multiple stakeholders together to achieve common goals in Forest Health, including: managing the Don't Move Firewood campaign, convening the Continental Dialogue on Non-native Forest Insects and Diseases, and working to improve the international biosecurity measures in place for solid wood packaging.

Purpose: To identify knowledge gaps, policy needs, management options, and educational opportunities related to pest incidence and pest mitigation in association with the production and utilization of solid wood packaging.

Abstract: The forest- to- recycling production chain for solid wood packaging material is examined with respect to the dynamics of wood-boring and hitchhiker pest incidence via the international supply chain. Each step of the production pathway is detailed and the current systems in place, published research, and regulatory environments are reported. Knowledge gaps and research opportunities are considered for each step and recommendation provided. This project lays out a big picture overview to allow for a full system review of where new or improved pest risk management strategies could be explored.

Participant questions:
Q: Reasonably accurate SWPM import under load/use estimates: can this group help?
A: Some papers published (USA/NZ) saying around 50% of containers include WPM.
Q: What do YOU think may be a weak link we should cover in this paper?
A: Dunnage may be the weak link in the management of pests in wood packaging material.

2.7 Summary, additional questions and discussion Ormsby/ Nehme

IPPC procedural issue to moving forward at the moment. Countries (NPPOs) can make this a priority for the IPPC to resolve.

Q: Increase in enforcement at the border since ISPM 15?
A: Yes, but depends on the country. Two types of WPM - sea or air containers, and dunnage (break-bulk). Heavy investment by NPPOs to moving WPM to ISPM 15 (still 10% not ISPM 15 certified). Should not be any WPM moving internationally not certified to ISPM 15. Data collected at ports but needs to be more scientifically collected (by research teams not border officers).

Discussion in EU on need to do ISPM 15 within EU as well as internationally. Industry not prepared but okay with it but countries say no (due to added costs on trade).

Difference between lethal dose and applied dose. Lethal dose does not change but applied dose will depend on the operational context. Important not to confuse those two things e.g., by saying the treatment is not working (not lethal) when not applied properly.

Q: Is there a wide understanding that establishment (risk) is more important than association (interception)? Industry wants support for moving on this concept further. Need to push ISPM 15 for environment benefits rather than just trade requirements e.g., we do it for good like global warming measures. Seems that we need both e.g., green and enforcement.
A: A single larva in a single piece of WPM is not an establishment risk. The implementation guide possibly can reflect this issue - albeit the formal risk assessment recommendation may have to reflect other ISPMs. Maybe this could assist industry to have more confidence in the standard.
Comment: What you described is a perfect example of what I'm trying to get at. But I want to be clear, industry has full confidence in ISPM 15. It's more about defending the program from a misunderstanding that an interception represents an absolute failure of the program.

Comment: I agree as I use a threshold for non-compliance and suspension of treatment providers which has some tolerance recognising that it takes more than one pest to reproduce! There is a lack of formal reporting of "failures" between countries to monitor performance.

Comment: Guide has three bodies - core and treatment modules. Core to include NPPO reporting/data gathering best practice.

Day 3 – October 14: PHYTOSANITARY ISSUES

3.1 Greetings & Introduction to IFQRG Ormsby/ Allen

Session Moderator: Kelli Hoover

Bio: Professor Kelli Hoover from Penn State University is internationally recognized for her research on invasive species biology and ecology; she has been working on a team for many years on development of radio frequency for treatment of wood packaging materials in compliance with ISPM-15 and has been a member of IFQRG since 2006.

3.2 Chemical treatments of wood products as a part of pest management under International Standards for Phytosanitary Measures UZUNOVIC

Author: Adnan Uzunovic

Presenter Bio: Adnan Uzunovic was a senior research scientist for over 20 years, at FPInnovations (Canadian Wood research institute), working on wood protection from pests that cause deterioration or market issues, developing various test methodologies, conducting research on the management of wood pests, and participating in different national and international forums. Adnan has been member of IFQRG since its establishment and other relevant groups serving various functions in support of IPPC phytosanitary standards development and their implementation, and member of International Group of Wood preservation. Currently Adnan provides scientific advice and representation to Canada Wood to support regulation and the biosecurity of wood products exports and imports.

Purpose: To review chemical treatments of wood products and initiate a discussion on the evaluation of processes and treatments as part of quarantine pest management.

Abstract: Wood-protection treatments are designed to preserve and safeguard wood from bio-deteriorating organisms, with the goal of extending wood-service longevity. Although most chemical treatments and processes have not been evaluated for efficacy against in situ pests (a requirement for phytosanitary treatments), some may fully eradicate pests in situ, or significantly reduce pest load and, prevent pest reinfestation after the treatment. Prior to chemical-wood treatment, wood is visually inspected for quality and cleanliness, debarked, and often dried, all of which are recognized measures to reduce pest risk. Chemical treatments penetrate to different depths in wood depending on the process employed. Chemical applications using heat and pressure further reduce pest risk. Ultimately, the process of chemically treating wood may result in rendering the wood essentially sterile. Chemical treatments and their effectiveness in reducing pest load and preventing infestation could be considered as components in a systems approach for consideration in bilateral trade negotiations. This presentation reviews chemical treatments, processes and their evaluation and discusses how they may be incorporated into pest-management regimes.

Participant questions:
Q: Why was the chemical treatment removed from ISPM 15?
A: Not environmentally friendly when burned so not considered appropriate for WPM, but the focus is on wood products other than WPM.

3.3 Update on the efficacy of the vacuum pressure impregnation with wood preservative products to eliminate pinewood nematode from wood FONSECA

Authors: Luís Fonseca, Hugo Silva, Isabel Abrantes

Presenter bio: Luís Fonseca is a PhD researcher at the Center for Functional Ecology, Department of Life Sciences, University of Coimbra, Portugal. He has published several articles in international scientific journals and has been involved in international and national projects focused on Pine Wilt Disease. He has been actively collaborating with Portuguese industrial companies of wood and bark treatment, the Portuguese Authority for Animal and Plant Health, and has participated in national inspections for the detection of pinewood nematode in pine forests in collaboration with the National Institute for Nature Conservation and Forests

Purpose: To assess the efficacy of the vacuum pressure impregnation process to eliminate pinewood nematode from wood

Abstract: To determine the efficacy of vacuum pressure impregnation with commercial wood preservative products to eliminate the quarantine organism, pinewood nematode (PWN), *Bursaphelenchus xylophilus*, and other nematodes from *Pinus pinaster* wood, laboratory and industrial activities are being conducted. Nematode mortality is assessed by *in vitro* laboratory assays through PWN direct exposure to different wood preservative products, and by industrial assays in autoclave tanks using naturally PWN infected *P. pinaster* trunks of various diameters, impregnated by vacuum and pressure with water and different commercial wood preservative products. New data will be presented and discussed.

Participant questions:
Q: What evidence there is that J3 juvenile PWN are more tolerant to heat or chemical preservatives. Was there a study done to compare life stages exposed to treatments?
A: [*Thomas Schroder*] It is the JIII stage, not the J3 one. JIII is developed under poor conditions for the nematodes. This stage can stand long time of starvation, desiccation as well as under water for months. It is the stage right before development of JIV which is transmitted by the vector. These are the reasons why it is believed by nematologists to be the most resistant life stage. [*Luís Fonseca*] For being considered the most resistant PWN stage, is important to have a high density in the wood when we want to evaluate efficacy of treatments
Q: Is there any data on efficacy of this treatment on Monochamus life stages?
A: No work as yet.
Q: For Products A, B, and C - what is human toxicity and other non-target organism toxicity? Any concerns?
A: EU approved for use at concentration limits.
Comment: For those interested in pinewood nematode, there is an IUFRO PWN webinar in November. Register here: https://symposium.inrae.fr/pwd2020/Registration-Webinar-Nov.-2021

3.4 Forest Biosecurity in Canada ALLISON

Authors: Jeremey Allison, Mireille Marcotte, Meghan Noseworthy and Tod Ramsfield

Purpose: To give an overview of the biosecurity situation in Canada

Abstract: The regulatory framework for forest biosecurity within Canada is described, with examples of pests that have established in Canadian forests or are anticipated to soon arrive. The agencies and

entities who contribute to biosecurity and collaborate on plant protection are identified, and their roles outlined. The regulator-science community relationship combined with the use of science-based policies, strategic and efficient border security and collaborations among government and non-government stakeholders have been important aspects of effective forest biosecurity in Canada.

Participant questions:
Q: We will discuss molecular identification development in depth next week from a technical standpoint but would like to ask this now on regulatory perspective while you are here. It can serve as a segue into next week. Molecular technique development for identification of pests is the fastest growing area of forest quarantine and biosecurity. The accuracy and efficiency of these techniques raises new questions for trade partners around responsibility and liability, among other things. These techniques can be a shock to a regulatory system when presented for use. In this regulatory-science community partnership that you refer to, how conscious is Canada and trade partners at making sure that molecular technology development does not get out ahead of regulatory understanding and acceptance?
Q: These control measures require years of research. What do you do in the interim with a new invasive?
Comment: eDNA versus viable propagule detection is important discussion point. There is some new work being done on detection of eRNA, which is time sensitive and degrades much faster than the DNA found in eDNA searches, which may help us on Jenny's good point of eDNA vs viable propagules.

3.5 FAO Forest Health Program 2021 Update SATHYAPALA

Author: Shiroma Sathyapala

Presenter Bio: Dr. Shiroma Sathyapala, Forestry Officer FAO has been leading the Forest Health and Protection Program in FAO, Rome, Italy since 2014. Through this programme, FAO assists, advises and supports countries and regions to safeguard the health and vitality of forests, forest ecosystems and trees outside forests, with special reference to insect pests, diseases and other harmful biotic and abiotic agents.

Purpose: To inform IFQRG members of upcoming FAO forest health activities and seek collaboration where appropriate

Abstract: The FAO forest protection and health programme assists, advises and supports countries to safeguard the health and vitality of forests, forest ecosystems and trees outside forests, with special reference to insect pests, diseases and other harmful biotic and abiotic agents. Through projects the program offers emergency assistance to countries with pest outbreaks and also develops pest management strategies to prevent further outbreaks in the medium and long term. In addition, FAO is facilitating four Regional Networks dedicated to the issue of forest invasive species. This presentation aims to provide updates on the Forest health program activities for 2021-2022.

Participant questions:
Comment: https://plantvillage.psu.edu/ PlantVillage and its mobile app — called "Nuru," which is Swahili for "light" — uses artificial intelligence and machine learning to train computers to recognize disease symptoms. When deployed on a smartphone, the app couples with the device's camera to capture images of diseased plants and provides the user with a preliminary diagnosis with a high degree of accuracy. The user also can get disease-management information and advice.
Comment: Here is the link to Join the Dgroup on Forest Health and Invasive Species (FISnet)!
https://dgroups.org/fao/fisnet/

3.6 Building forest health & biosecurity capacity in SE Asia LAWSON

Author: Dr. Simon Lawson

Presenter Bio: Dr. Simon Lawson is an Associate Professor in Forest Health at the University of the Sunshine Coast (USC), Director of the Biological Control of Eucalypt Pests Alliance (BiCEP), and Co-coordinator of the Asia-Pacific Forest Invasive Species Network. Prior to joining USC he was team leader for forest health research in the Queensland Department of Agriculture and Fisheries (DAF) from 2006-2015, and has over 40 years' experience in forest entomological research in Australia and internationally. His research focus is on developing effective, sustainable management methods for insect pests of plantation forests, with an emphasis on biological control. He also has strong interests in forest biosecurity, population modelling, and in international collaborations in forest health and biosecurity.

Purpose: Inform the IFQRG group of new Australian Centre for International Agricultural Research (ACIAR) projects in SE Asia establishing a forest biosecurity network and the tools needed to support it.

Abstract: Forest biosecurity capacity varies widely across SE Asia but is generally low, especially in low-income countries. In response to this need, an Australian Centre for International Agricultural Research (ACIAR) scoping project for the region determined current biosecurity capacity, knowledge, and priorities; reviewed regulations, laws, trade conventions, and treaties for biosecurity and summarised past and current investment in biosecurity within forestry, horticulture, and agriculture in the SE Asia region; and began to initiate and grow a network delivering coordinated responses and enhanced capability, including bridging the link between forest and agricultural biosecurity institutions. From this review, two new four-year ACIAR projects in the region were developed, focusing on (1) establishing a forest biosecurity network and (2) developing the science tools to support the network.

Participant questions:
Comment: For questions for Simon, please email: SLawson@usc.edu.au

3.7 Dealing with dirty data: outliers, inliers, and avoiding being liars ALLEN

Author: Dr. Eric Allen

Presenter bio: Dr. Eric Allen, now retired, was head of the Forest Invasive Alien Team with the Canadian Forest Service at the Pacific Forestry Centre in Victoria, Canada for more than 20 years. He worked extensively on non-indigenous species that impact forest ecosystems, their biology, their movement with international trade, and assessment of mitigation measures. During his career he was the founder and chair of the International Forestry Quarantine Research Group (IFQRG) and a member of the North American Plant Protection Organization (NAPPO) expert group on forestry systems approaches and the International Plant Protection Convention (IPPC) Technical Panel on Forest Quarantine. He now serves as a phytosanitary consultant for the World Bank and the National Wood Pallet and Container Association and continues to provide support to IFQRG and NAPPO.

Purpose: To address an action item arising from the 2019 IFQRG meeting, this presentation aims to stimulate discussion on the treatment of data outliers in phytosanitary research.

Abstract: In the process of designing scientific experiments, collecting, analyzing and interpreting information, researchers are often confronted with unexpected data points. These can represent actual variation in the test population or be the result of errors in data collection, recording or transcription. Researchers should develop a data cleaning plan a priori, including whether and how erroneous data

points should be excluded from analysis and reporting. Policy implications for phytosanitary research are discussed.

Participant questions:

Comment: Journal reviewers differ greatly on what they accept for inclusion in a submitted manuscript. We had equipment failure on the last replicate of log treatment trials. We included that in a sentence in the manuscript, but our efficacy data table did not include this replicate for that reason (i.e. full-treatment not achieved). Reviewer wanted any data for that entire replicate removed from the manuscript.

Comment: I would also add that there are a number of modern statistical approaches that can objectively assess the 'outlierness' of a data point. These can, for instance give an estimate of probability of making a similar observation.

3.8 Summary, additional questions and discussion Ormsby/ Nehme

This question pertains to both Adnan and Luis' presentations today. While there may be questions around quarantine safe efficacy, wood protection treatments have obvious advantages over ISPM-15 approved treatments: 1. greater residual activity and effective lifespan in wood compared to heat treatment and fumigation; 2. inadequate treatment due to poor technique and outright fraud are the leading causes of ISPM-15 failure. Wood protection treatments in many cases are easily proved visually or could be made so if necessary. How then can we leverage these advantages so that wood protection treatments have a role in overall phytosanitary treatment strategy and risk reduction?

The issue of granularity (lumping all types of wood packaging, pallets, crates, dunnage, ISPM 15 certified, not certified) does not allow science to adequately assess the effectiveness of ISPM 15. There is a need to standardize data collection and reporting re WPM pest interception to differentiate various types of WPM. Marcel Dawson, CWPCA

Issue around definitions for "secondary pests" for IPPC - subgroup to resolve - Brad, Meghan, Thomas, Eric.

Day 4 – October 21: MOLECULAR TOOLS

4.1 Daily Update Ormsby/ Allen

Session Moderator: Dr. Mike Ormsby

Bio: Dr. Mike Ormsby manages a team of scientists in the New Zealand Ministry of Primary Industries that assesses pest risks to New Zealand and oversees research programmes to support pest management. Dr Ormsby has worked in the phytosanitary area for over 24 years and has been a member of IFQRG and the IPPC technical panels for treatments and forest quarantine since 2005.

4.2 A rapid identification of forest pests at the borders using MinION sequencing of DNA barcodes ABEYNAYAKE

Authors: Abeynayake, Shamila[1]., Fiorito, S[1]., Dinsdale, A[1]., Whattam, M.[1]., Crowe, B[2]., Gambley, C [3]., and Campbell, P[3].
[1] Plant Innovation Centre, Plant Import Operations, Biosecurity Plant Division, Department of Agriculture, Water and the Environment (DAWE), [2]Operational Science and Surveillance, Science and Surveillance Group, Biosecurity Operations Division, DAWE [3]Microbiology and Entomology, Biosciences, Queensland Department of Agriculture and Fisheries (QDAF)

Presenter bio: Dr. Shamila Weerakoon Abeynayake is a molecular scientist at the Plant Innovation Centre in the Department of Agriculture, Water and Environment (PIC@PEQ). Having a background in molecular biology, microbiology along with biosecurity research at the Plant Innovation Centre, Shamila is currently using next-generation sequencing (NGS) technologies to identify invertebrate pests and high-risk pathogens for biosecurity.

Purpose: Molecular diagnostic tools

Abstract: Rapid and accurate identification of forest pests and their immature life stages detected at the border is a challenging task. Current diagnostic methods used at the borders are mainly based on time consuming visual and microscopic examinations. Here, we demonstrate a rapid in-house workflow for Oxford Nanopore Technologies (ONT) MinION sequencing of DNA barcodes for identification of invertebrates. Overall, the results suggest that MinION sequencing of DNA barcodes offers a complementary tool to the existing morphological diagnostic approaches to provide rapid and accurate evidence for identifying invertebrates including forest pests at the border.

Participant questions:
Comment: New workflow for a NGS at a PEQ.

4.3 BioSurveillance of Alien Forest Enemies (BioSAFE) - genomics-enhanced detection and surveillance tools HAMELIN

Author: Dr. Richard Hamelin

Presenter Bio: Dr. Richard Hamelin obtained a B.Sc. from McGill University in 1982, a Master's of Pest Management from Simon Fraser University in 1986 and a Ph.D. from the University of Kentucky in 1990. He has 30 years of experience in forest health research and has published over 160 peer-reviewed scientific articles. His work aims at using genomics to better understand forest disease epidemics in the face of climate change and globalization and to design detection and monitoring methods that can help mitigate future epidemics. He was president of the Canadian Phytopathological Society and the Quebec

Society for Plant Protection and was awarded the Fellowship of the American Phytopathological Society (2020) International Union of Forest Research Organization Scientific Achievement Award (2014), the Queen Elizabeth II Diamond Jubilee award (2012), Merit Awards from Natural Resources Canada (2008), the Canadian Forest service (2008), the Canadian Food Inspection Agency (2007), and the Quebec Society for Plant Protection (2008) for his pioneering work on the application of genomics in forest protection.

Purpose/ Abstract: The project's mission is to develop the next generation of genomic surveillance tools for biosurveillance of invasive insects and pathogens. These tools allow rapid and accurate taxonomic identification, determination of origin and can provide information useful for risk assessment. The final goal is to provide the end users with a decision-support system to guide their management and mitigation actions. This presentation will give an update on the BioSAFE project and its path toward implementation.

Participant questions:
Comment: Discussion on the limitations of sequencing reference databases and the efforts to improve this area, and the significance of the more recent dominance of a particular SOD type (aka Delta Covid).

4.4 Molecular diagnostics of forest pest insects and their biological control agents at USDA APHIS PPQ WU

Author: Yunke Wu

Presenter Bio: Yunke Wu completed his Bachelor's degree in China and obtained his Ph.D. from Harvard University in 2013. He has been working under a cooperative agreement between USDA and Cornell University, focusing on molecular diagnostics and population genetics of various forest pest insects and their biocontrol agents. His research interests include systematics, molecular phylogenetics, species delimitation, and biogeography.

Purpose: To provide an overview of various molecular diagnostic tools used by APHIS PPQ to strengthen biosecurity.

Abstract: USDA Plant Protection and Quarantine (PPQ) Science and Technology (S&T) provides scientific and analytical support for PPQ regulatory decisions and program operations. At the S&T Forest Pest Methods Lab, his group develops and utilizes molecular diagnostic tools for detection, survey and control of exotic plant pests, such as Asian gypsy moth, Asian longhorned beetle, spotted lanternfly, velvet longhorned beetle, Japanese beetle, etc. Their tools range from restriction fragment length polymorphism (RFLP) analysis, real-time PCR, DNA barcoding, and next-generation sequencing. These diagnostic assays allow PPQ to rapidly recognize and respond to biological invasions.

Participant questions:
Q: Is the USDA working on applying Spotted Lantern Fly biocontrol currently?
A: It is one of the tools under development. As you can see, it is much more complicated than we expected. There are two parasitoid wasps that are under evaluation, one is *Anastatus orientalis*, another one is *Dryinus sinicus*. It will be a long way before either can be approved for release.
Comment: AGM - populations in China can be tracked to populations in USA. Mid plains equate to most introductions. SLF parasite Anastatus has braod host range. Wood-boring larvae interception in WPM - difficult to identify larvae to species - use Barcoding - many species detected. Genetic data can be more precise than isotopic analysis (if found on same latitude).

4.5 Phytosanitary risks associated with the movement of tree seeds and dormant twigs FRANIC

Authors: Iva Franić, Rene Eschen and Simone Prospero

Presenter Bio: For her Ph.D. project Dr. Iva Franić studied insect and fungal communities of tree seeds and twigs on a large scale to determine the main drivers of the observed diversity patterns and to assess the phytosanitary risk associated with the movement of plant material. She obtained her PhD from University of Bern and has been working on her project at CABI Delémont and WSL in Switzerland. She is currently doing her postdoc at Southern Swedish Forest Research Centre, SLU Alnarp where she looks more closely into vertical transmission of fungal endophytes of tree seeds.

Abstract: We investigated the diversity of fungi associated with tree seeds and dormant twigs of a large number of hosts and on a broad geographic scale using traditional and molecular methods. Our results reveal high diversity of tree-associated fungi, including the presence of potential pathogens that could be moved with the exchange of plants. Here we discuss the risk of introduction of pathogens through movement of plants for planting, the use of different methods for the detection of tree-associated fungi, and gaps in knowledge that need to be addressed for better risk assessment.

Participant questions:
Q: Evidence of moving in trade?
A: Pine Pitch Canker yes.
Comment: HTS better than Culturing (but alive?). 10 pathogenic species to EU detected on seed/twigs. Potential to use more sophisticated techniques for culturing. Vertical transmission - looked at flowers/cones/pollen etc to see how seed infested? Coming during pollination (seems). Tested with equal volumes of 8 mixed spores and found HTS did not represent all species or abundance. (is it a bioinformatics problem, or a sampling problem, or a sequencing problem, primer bias?).

4.6 eRNA for detection and viability profiling: tool development using a pinewood nematode model BLACKBURN

Author: Dr. Gwylim Blackburn

Presenter bio: Dr. Gwylim Blackburn is a research scientist of entomology at the Pacific Forestry Centre (CFS) in Victoria, BC. In his research, he develops tools aimed at advancing pest risk assessment and phytosanitary policy by combining field and lab-based sampling techniques with genomic analysis to illuminate aspects of insect biology that are key to assessing and managing their impact on forests and urban trees.

Abstract: We aim to develop a diagnostic tool based on samples of environmental RNA (“eRNA”) that detects and evaluates the viability of pests in wood products. Genetic tools in general are bound to play an increasing role in forestry and biosurveillance, which is made possible by the ever-increasing accessibility of genetic data. Capabilities of this technology include rapid species identification and profiling for traits that mediate biosecurity risks. Realizing this potential requires research to establish tool limits and standards of application to provide harmonized guidance for their practical use. I will discuss the potential of eRNA for phytosanitary applications and our current research to develop an eRNA diagnostic tool using pinewood nematode (*Bursaphelenchus xylophilus*, PWN) as a model. The tool will enable: (1) detection of even trace genetic signatures of PWN directly within wood products, and; (2) viability profiling of these signatures to distinguish living PWN from residual dead tissue that can linger in wood even following phytosanitary treatment. We expect this tool to promote confidence in

the efficacy of phytosanitary wood treatments and measures, and to guide responsible eRNA tool development for other species.

Participant questions:
Comment: 96 hours post treatment can still detect RNA in *Phytophthora*. This is advantageous in one sense, as it makes the sampling more robust (time wise), but yes a concern in phytosanitary use. Need to determine how long (e.g., container journey long enough). Stay in touch with NPPO over needs and confidence. Collaboration worldwide and in regulatory areas for development.

4.7 Summary, additional questions and discussion Ormsby/ Nehme

Are these technologies available to developing countries? IPPC guidance document on using this technology (https://assets.ippc.int/static/media/files/publication/en/2021/07/R-08_En_2019-05-06_Post-CPM-14_Fixed-BackCover.pdf). Important points are included such as taking genomic results in context with risk analysis, other diagnostic methods results, etc.

HTS can help us keep an eye on things we do not know but focus on the things we do know (top X pests etc.).

DPs are out of date. @Adnan: it is also due to the long-lasting IPPC process to get a DP published that DPs are somewhat outdated. The PWN DP took me 10 years from starting to be published…

Way to go before metabarcoding replaces PCR. Metabarcoding can be used as an indicator that can then be followed-up with PCR. Regulators need to know about potential issues not to prevent release but to prepare for possible downsides (e.g., prepare a communication plan with other countries).

Is there a benefit from doing the database properly (at international level and properly curated and supported for future use etc.)?

https://mycokeys.pensoft.net/articles.php?id=20887

IFQRG has a role in advocacy for traditional mycology and the need for those skills.

13. Review of IFQRG-17 report

The meeting report was reviewed by the SSC before adoption.

14. Close of Meeting

The Chair thanked the participants for their commitment and participation and hoped that we will be able to meet in person next year in Rome.

Appendix 1: List of Participants at IFQRG 18

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