International Meeting # 20

7, 14, 21, 28 of November 2023

Proceedings of the Virtual Symposium

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

Disclaimer

Symposium Proceedings

These proceedings communicate the discussions and conclusions from the 2023 International symposium number 20 of the International Forestry Quarantine Research Group. The symposium was held on-line (virtually) on the 7th, 14th, 21st and 28th November 2023.

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 (C2N2)
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

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.

MEETING REPORT

1. Welcome Address

The meeting of IFQRG-20 was hosted online by the Food and Agriculture Organization (FAO) Rome, Italy. 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

Day 1 - Tuesday, Nov 7th

Time		Molecular Tools	Speaker
11:00	1.0	Greetings	Mike Ormsby
11:05	1.1	Introduction to IFQRG	Eric Allen
		Session moderator	Adnan Uzunovic
11:15	1.2	Progress in national standards development to support the use of eRNA for the detection of live PWN and to assess the efficacy of phytosanitary measures	Caren Helbing
11:35	1.3	Molecular detection of living *Phytophthora* species of phytosanitary concern to assess efficacy of wood heat treatment	Isabel Leal
11:55	1.4	RNA-based metabarcoding for the assessment of viable fungi in tree seeds	Iva Franic
12:15	1.5	Advances in Molecular Diagnostics of Spongy Moth (*Lyr*	Yunke Wu
12:55	1.6	Summary, additional questions and discussion	Adnan Uzunovic, Ron Mack

Day 2 - Tuesday, Nov 14th

Time		Phytosanitary Treatments I	Speaker
11:00	2.0	Greetings & Introduction to IFQRG	Mike Ormsby, Eric Allen
		Session moderator	Ron Mack
11:15	2.1	International Plant Protection Organization (IPPC) update	Janka Kiss
11:35	2.2	Food and Agriculture Organization (FAO) Forestry Upda	Shiroma Sathyapala
11:55	2.3	European and Mediterranean Plant Protection Organization (EPPO): update on activities and invitation to collaborate in the field of quarantine forest pests	Dmitrii Musolin
12:15	2.4	Wood chips in global trade, market issues and possible solutions - Canadian perspective	Adnan Uzunovic
12:35	2.5	Heat treatment of wood chips: no need to reinvent the wheel!	Jean-Marc Henin
12:55	2.6	Preparation of an EPPO guidance document for managing the risks associated with international trade in wood chips	Xavier Tassus
13:15	2.7	Summary, additional questions and discussion	Ron Mack, Kelli Hoover

Day 3 - Tuesday, Nov 21st

Time		Phytosanitary Treatments II	Speaker
11:00	3.0	Daily update/ IFQRG Introduction	Mike Ormsby, Eric Allen
		Session moderator	Eric Allen
11:15	3.1	IPPC Technical Panel on Phytosanitary Treatments Update (TPPT)	Mike Ormsby
11:35	3.2	Alternatives to methyl bromide - Update on the research and registration status, relevant working groups and options in 2023/2024	Adnan Uzunovic
11:55	3.3	Commercial-scale validation of the efficacy of ethanedinitrile against the sirex woodwasp (*Sirex noctilio*) in naturally-infested pine (*Pinus radiata* D.Don) wood	Matt Hall
12:15	3.4	The Canadian shipborne dunnage program	Hugo Frechette
12:35	3.5	Evaluating the risk associated with different categories of wood packaging material	Meghan Noseworthy
12:55	3.6	Summary, additional questions and discussion	Eric Allen, Mike Ormsby

Day 4 - Tuesday Nov 28th

Time		New tools and technology	Speaker
11:00	4.0	Daily update/ IFQRG Introduction	Mike Ormsby, Eric Allen
		Session moderator	Thomas Schröder
11:15	4.1	Carbon accounting and forests	Carolyn Smyth
11:35	4.2	Carbon and the Wood Packaging Industry: Finding a path forward	Brad Gething
11:55	4.3	Insect and disease disturbances and their carbon impacts in forests	Leigh Greenwood
12:15	4.4	Heat treatment of EAB prepupae– sub-lethal temperature effects at the molecular level	Holly Williams
12:35	4.5	International Standard for Phytosanitary Measures (ISPM) 15 - New Treatments	Mike Ormsby
12:55	4.6	Summary, additional questions and discussion	Thomas Schröder, Mike Ormsby

5. Presentations

1. Molecular Tools – Day 1 – November 7th

Session Moderator: Adnan Uzunovic

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 a 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.

1.1 Introduction to the International Forestry Quarantine Research Group (IFQRG) - *Allen*

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), member of the North American Plant Protection Organization (NAPPO) Forestry Panel and expert groups on Forestry Systems Approaches and Contaminating Organisms and the International Plant Protection Convention (IPPC) Technical Panel on Forest Quarantine (TPFQ). 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 teamwork and collaboration through bringing global experts from science, industry and regulatory communities together to solve phytosanitary issues in forestry.

Summary: The International Forestry Quarantine Research Group, created in 2003, had its first meeting in Rome in February 2004. Since then, 19 meetings have been held, many in Rome, but also in Canada, Portugal, Australia, Wales, China, New Zealand and Brazil. This year the meeting was held online as a virtual symposium. 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 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 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 in 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.

1.2 Progress in national standards development to support the use of environmental RNA for the detection of live pinewood nematodes and to assess the efficacy of phytosanitary measures - *Helbing*

Authors: Caren C. Helbing[1], Gwylim Blackburn[2], Isabel Leal[2], Stacey Kus[3], Vanessa C. Thompson[1], Esme John[2], Adnan Uzunovic[4], Jacob J. Imbery[1], Luís Fonseca[5], and Joana Cardoso[5]

[1]*Department of Biochemistry and Microbiology, University of Victoria, Victoria, British Columbia, Canada,*
[2]*Pacific Forestry Centre, Natural Resources Canada, Victoria, British Columbia, Canada*
[3] *FPInnovations, Vancouver, British Columbia, Canada*
[5]*Canada Wood Group, Vancouver, British Columbia, Canada*
[5]*Centre for Functional Ecology, Department of Life Sciences, University of Coimbra, Coimbra, Portugal*

Presenter Bio: Dr Caren Helbing is a Professor in the Department of Biochemistry & Microbiology at the University of Victoria in British Columbia, Canada. She directs an internationally recognized research group that investigates biomolecules to understand and promote animal, environmental, and ecosystem health. She is shared co-lead of the iTrackDNA

Genome Canada/BC/Québec large-scale applied research project that introduces innovations in non-destructive precision genomics for environmental impact tracking in a global climate change era.

Abstract: Conventional pinewood nematode, *Bursaphelenchus xylophilus*, detection in wood products involves morphological analysis of species-specific characteristics after nematode extraction from wood. This analysis is time-consuming and requires specialized expertise in nematode morphology and taxonomy. Moreover, morphological distinction of eggs and juvenile stages from other related species is problematic, prompting the need for gDNA-based discrimination methods. However, these methods can only detect nematode presence, not viability. Because only living organisms are regulated as quarantine concerns, molecular tools that can distinguish between live and dead pinewood nematodes, such as those based upon short lived RNA molecules, will provide increased confidence in confirming the effectiveness of phytosanitary measures, including new phytosanitary treatments. This presentation discusses the progress made on developing environmental RNA-based assays as a means for viable pinewood nematode detection in wood products and how recent publication of national standards for environmental DNA will improve confidence in use and uptake.

Discussion: Karen indicated that their group is aiming to break down barriers for confident eDNA/RNA use for a variety of applications and improved confidence in decision-making using pine wood nematode as a model. She pointed out there are two recently introduced Canadian standards published by the Canadian Standards Association. The first, CSA W214:21, published Nov 2021, titled "eDNA reporting Requirements and Terminology" addresses the minimum requirements for reporting in eDNA projects including survey design, data collection, different substrates, labeling and handling, extraction of nucleic acids, analytical methods, analysis and interpretation of the data, and assessment of false positives and negatives. A CSA standard is developed through an 18-month process involving all stakeholders and allows for a 2-month global review. The final document is open, can be used by anyone, and is reviewed at least every 5 years. The second standard: CSA W219:23 titled "Performance Criteria for the Analyses of eDNA by Targeted QPCR" is scheduled to be released in Nov/Dec 2023. It focuses on the minimum level of performance, quality control, and validation criteria especially in field application of eDNA/RNA technologies. Karen discussed the complexities behind developing suitable eDNA/RNA assays.

There are other recently developed, or under development, guidelines/standards including: The Australian/New Zealand best practices guidelines for the use of eDNA/eRNA: "Environmental DNA protocol development guide for biomonitoring" and "Environmental DNA test validation guidelines". Both also address the use of eRNA and are published as open access documents. The National eDNA Reference Centre was formed to validate, maintain and optimize assays and to provide high quality standards for environmental DNA use in Australia, New Zealand and the Asia-Pacific region. The EU COST action DNAqua-Net published a practical guide to DNA based methods for biodiversity assessments (2021). The EU-funded VALITEST project

published “Guidelines for the reliable use of high throughput sequencing technologies to detect plant pathogens and pests” (Massart et al. 2022) and EPPO released the PM7/151 (1) standard (April 2023) “Considerations for the use of high throughput sequencing in plant health diagnostics. There is an invitation to contribute to a special issue on standardization of molecular biodiversity monitoring by the journal Metabarcoding and Metagenomics (MBMG) following the GEO BON 2023 conference and the launch of ISO task force. The IPPC (2019) published “Recommendation on: preparing to use HTS technologies as a diagnostic tool for phytosanitary purposes”. The point was made that guidelines are not standards and Canada is so far the only country that has a published standard. It defines what you need to do in order to have confidence in results.

Also noted were the challenges on delivering target kill dose (heat, fumigants) to the center of larger diameter wood materials such as logs where some nematodes may survive and rapidly re-establish the population. He asked for an opinion on how to use this technology and what is the best sampling pattern to address those challenges. Karen indicated that her team had a lot of discussions on the best sampling patterns and how to address different scenarios. There can be a lot of variability in sampling for assays so there is a need to develop the best methodology for a given scenario.

The heat ramps were also discussed. A quick ramp up time was used; however, in the next stage the group will look into slower ramp down times, closer to what would occur in a kiln treatment. They will also look into the time required for RNA to degrade post treatment to find optimal sampling times to eliminate false positives caused by the presence of non-degraded DNA present before the time of death.

56/30 does kill all nematode stages, as confirmed in controls where nematodes were observed dead. In the experiment shown, RNA was sampled too soon after treatment, and false positive results were obtained. More time after treatment is needed to allow RNA to completely degrade.

Research Needs: A better understanding of the RNA degradation process and the best time to sample to eliminate false positive results in situations where an organism has been killed but detectable RNA remains.

1.3 Molecular detection of living *Phytophthora* species of phytosanitary concern to assess efficacy of wood heat treatment - *Leal*

Authors: Isabel Leal[1], Nicolas Feau[1], Adnan Uzunovic[2], Brett Foord[3] and Richard Hamelin[4]

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[4]*Department of Forest and Conservation Sciences, Faculty of Forestry, University of British Columbia, Vancouver, BC, Canada.*

Presenter Bio: Dr. Isabel Leal is a research scientist at the Pacific Forestry Centre, CFS, Natural Resources Canada. During her career, she has worked on developing various diagnostic molecular methods to detect pine wood nematode, *Bursaphelenchus xylophilus*, and *Phytophthora* species of phytosanitary concern in wood. She has also carried out studies of molecular characterization, identification and genetic diversity of several host-pathogen and host-insect systems and used phylogenetic analyses to elucidate pathways of non-native weevil entries into Canada. More recently, she has applied genome-wide associations and transcriptomic analysis to the identification of candidate genes for drought tolerance and Swiss needle cast in Douglas-fir and has worked on the quantitative evaluation of root and butt rot disease in western red cedar by MiSeq.

Abstract: International trade in wood products constitutes an important component of the global economy. However, wood and wood products may have insects, parasitic nematodes and pathogenic pests associated with them that could potentially be introduced and become established in importing countries, thus posing phytosanitary risks. These risks could result in the implementation of phytosanitary restrictions that may affect trade. The application of heat to kill pests associated with wood products has been a successful phytosanitary treatment used to prevent their spread. To evaluate the efficacy of a phytosanitary treatment, including heat for the elimination of pathogens, the method of choice is to isolate and grow microbes in petri dishes for subsequent morphological identification. Apart from requiring substantial expertise and time before identification can be attempted, some of these plant pathogens can be difficult or impossible to grow in cultures. Molecular based methodology capable of detecting plant pathogens in wood would be useful for corroborating morphological identifications, but it can also be used directly to fully validate on its own the presence of pathogens. DNA-based diagnostic molecular methods can detect the presence of microorganisms, but not whether they are dead or alive. In contrast, RNA, which is responsible for the transcription of genes, becomes rapidly unstable after cell death, thereby providing a measure of viability. We designed and tested RNA-based molecular diagnostic assays targeting genes essential to vital processes. We assessed their presence after heat treatment in wood colonized by four *Phytophthora* species of phytosanitary concern (*P. alni*, *P. cinnamomi*, *P. lateralis* and *P. ramorum*) through reverse transcription and real-time polymerase chain reaction (RT-qPCR). We validated these RT-qPCR

assays to assess heat treatment efficacy of Phytophthora-inoculated wood. These assays can be used as an effective tool to detect the presence of living pathogens in wood products and the effectiveness of current and emerging phytosanitary wood treatments.

Discussion:

Q: In regard to the selection of genes for different species, are those genes constitutively expressed?

A: Yes, they also have metabolic processes that will not be affected by environmental changes.

Q: Is there minimal expression of those genes under normal conditions?

A: Yes, and they were chosen because they are highly expressed. Analysis of Proteomic information was used to select the genes. The most challenging part of this work was the number of PCR reactions required, three PCR amplifications for each biological sample, and also heat treatment in wood and inoculation of the wood.

Q: Have you thought of a sampling schedule if you have to take these tools in the field to help a regulator make a decision?

A: Similar to PWN, we will have to sample from several parts and areas depending on the wood and the scenario.

Q: Has any test been carried out with naturally infested wood?

A: No, tests were on lab inoculated wood; using naturally infested material would be nice to do in the last stages of verification. Hopefully molecular technology will also help us to understand sublethal effects of treatment on pests. It is going to be very important to fill in a lot of current knowledge gaps regarding responses to specific scenarios e.g. having appropriate RNA seq data would go a long way in providing necessary information to address questions on which genes would be appropriate to use for assay development. We also need good reference genomes for pests of interest.

Research Needs:

- The best sampling schemes for different scenarios using molecular tools
- Verification on naturally infested wood
- Eric: Which genes related to/signaling sublethal effect of a treatment, are important? Apply molecular technology using those genes.
- Genomic information for organisms of interest.

1.4 RNA-based metabarcoding for the assessment of viable fungi in tree seeds - *Franic*

Authors: Iva Franić[1,2], Patrick Sherwood[1], Oskar Skogström[3] and Michelle Cleary[1]

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[3] *Svenska Skogsplantor, Sveaskog, Nyhammar, Sweden*

Presenter Bio: Dr Iva Franic is a scientist in the Phytopathology Group at WSL where she is working on different topics related to tree microbiomes and native and non-native forest pathogens. Previously, she 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. Iva obtained her PhD from University of Bern and worked on her project at CABI Delémont and WSL in Switzerland. She worked on her postdoc at Southern Swedish Forest Research Centre, SLU Alnarp where she looked more closely into vertical transmission of fungal endophytes of tree seeds, phytosanitary treatments of seeds, and utilization of various molecular methods for the assessment of fungal communities in plant tissues.

Abstract: Recent studies have shown that DNA-based metabarcoding has great potential for characterizing potentially pathogenic fungi directly from asymptomatic tree seeds. However, the value of this method for phytosanitary purposes remains unclear, as DNA molecules can remain stable and thus detectable for years after the death of the organism. The use of RNA instead of DNA molecules as targets for metabarcoding would allow identification of viable pathogens, but this approach has been poorly studied. Here we report the results of studies comparing fungal communities identified by traditional culturing, DNA-based and RNA-based metabarcoding from the same samples of commercially traded seeds. In addition, we show the results of a study that evaluated the efficacy of heat and UVC treatments for eliminating fungi in conifer seeds in which traditional culturing and RNA-based metabarcoding were used for assessing fungi in treated and non-treated seeds. The results of our studies contribute to improved detection of viable seed-borne pathogens and allow for better risk mitigation against tree seed pathogens.

Discussion: Molecular methods (metabarcoding studies, DNA based) revealed higher diversity of seed-borne fungi than previously anticipated, high infection levels, a large fraction of unknown species and plant pathogens, however they do not discriminate viable/active organisms from dead ones. In the study on seeds, RNA metabarcoding revealed more sequence reads and more OTUs (fungal taxa) identified to genus and species than DNA metabarcoding. Taxa appearing in both data sets are viable and active (versus those found only in DNA metabarcoding which could represent organisms that are no longer present or active in the seeds).

Q: Have you also looked into degradation of RNA and how it can confuse the results on viability after treatment?

A: RNA was not sampled immediately. All treatments were done in summer, and samples were put in the freezer and processed in autumn.

Q: What advice or caution would you give to the regulatory community related to the results you just shared with us?

A: Regulators may see some of these techniques that they can use but there are concerns and caution is needed. We are not ready to use this methodology for regulatory purposes and need to continue studies. We do not understand the technology fully yet. In this study the big question for example was how many reads is enough to be worried about something and the time for RNA to degrade post treatment.

Q: The last study shows that 55 °C for 8 hours and UV did not kill the fungi in treated conifer seeds. Is that correct?

A: Yes, that is correct, results depended on the shape and size of seeds, the fungal communities and the species.

Q: Would the high temperature affect the seeds and what temperature would be more appropriate to kill fungi?

A: None of the treatments affected seed germination as we used conifer seeds that are drier and more heat tolerant. We would not be able to use those temperatures on seeds with higher moisture. We even treated seeds at higher temperatures (e.g. up to 75 °C) for a shorter time (4 hours) and that did not affect germination. We did not check fungal mortality in those studies.

Q: Were culturing results more similar to RNA, DNA or both?

A: There were no clear patterns. In general, the diversity we get with culturing was much lower. For culturing we identified fungi based on the whole ITS region which is a long sequence and allows quite precise identification, while metabarcoding is done on short reads that are less precise.

Research Needs: Dormancy of seeds and germinated seeds are important factors affecting the data sets, so more studies are needed to understand the potential of RNA metabarcoding for the biosecurity purposes. Need to develop sensitive and reliable high-throughput molecular methods for better pathogen detection.

We need to test some of the species that survived in the Humble water bath to confirm if they are really alive after exposure to 55 °C or if the results are due to using molecular technology.

1.5 Advances in Molecular Diagnostics of Spongy Moth (*Lymantria dispar*) - *Wu*

Author: Yunke Wu

Presenter Bio: Yunke Wu is a Senior Research Scientist working under the cooperative agreement between USDA APHIS PPQ and University of Richmond. He obtained his PhD on evolutionary biology from Harvard University. His recent research projects include development of molecular diagnostic tools for invasive insects, studies on genetic diversity of invasive pest insects and their biological control agents, and loss of female flight capability in spongy moth hybrids.

Abstract: USDA APHIS PPQ has been conducting molecular diagnostics of spongy moth (*Lymantria dispar*) using conventional PCR for over 30 years. Between 4000-8000 moth samples from domestic surveys and port interception are processed annually. We collaborated with the Canadian Forest Service to develop a series of multiplex real-time PCR assays to replace those decade-old tools. New assays increase processing efficiency, accuracy, and diagnostic power. After full implementation of the new assays in the 2022 season, we continue to optimize the assays to meet the growing demand from the spongy moth survey.

Discussion:

Q: Was there a molecular work around for the sources of molecular error on the Asian mainland samples to distinguish them from similar European sequences? Or is there a need to find different diagnostic markers?

A: There is a separate assay using a different marker that is probably able to identify the peculiar population as *L. dispar* asiatica. It has not been widely validated, only using a few published sequences. It has been used in preliminary experiments on domestic catches of asian subspecies for example in Washington and Oregon along with traditional diagnostic tools. But it has not been corroborated as an official diagnostic tool. The additional sampling from Asia will be helpful in confirming the diagnostic tools.

Q: Given introgression is one explanation for the results, do you know how you could test that hypothesis?

A: It can be done depending on interest and funding to support it.

1.6 Adriana Moreira (Standards Setting Officer, Deputy to Unit Leader to the FAO)

Bio: Adriana Moreira coordinates the work of the IPPC Standards Committee, IPPC technical panels and expert working groups, which contribute to drafting International Standards for Phytosanitary Measures (ISPMs). Previously, she was the IPPC Secretariat lead for the Technical Panel on Diagnostic Protocols. Adriana is the IPPC Secretariat's liaison with several international organizations, helping to ensure mutual interest agreements for implementation of IPPC strategic objectives, mission and vision. She has authored and co-authored several

scientific publications, book chapters and training materials. In 2019, she was recognized as one of the FAO 100 Young Employees. Before joining the IPPC, Adriana was a senior plant pathologist in the multinational seed industry. As a plant quarantine lead, she coordinated a post-entry quarantine station accredited by the Brazilian national plant protection organization. Adriana has a PhD in plant pathology, focusing on plant virology. She speaks English, Portuguese, and Spanish.

Summary: Adriana gave an update on the status of molecular tools, in particular on emerging tools, at the IPPC level. The use of molecular tools to distinguish live or dead was debated by policy makers and the IPPC. The CPM approved the recommendation on the use of HTS technology (published in 2019) https://www.ippc.int/en/publications/87199/. IPPC diagnostic protocols follow ISPM 27 and must include the most reliable, accurate and reproducible methods for pest diagnosis; diagnostic protocols should be accessible to all 185 contracting parties, taking into account the different levels of technical capacities of the members. ISPM 27 includes several types of methods. The technical panel on diagnostic protocols (TPDP https://www.ippc.int/en/core-activities/standards-setting/expert-drafting-groups/technical-panels/technical-panel-diagnostic-protocols/) considers different methods including morphology-based diagnostics, various keys, and also advanced molecular technologies as long as they are reliable and accurate. A topic proposal was received recently to develop a diagnostic protocol using HTS for a bacterium. There are ongoing discussions at the IPPC level on approaches to molecular detection. Norman Bar, an expert in molecular techniques from USDA APHIS is invited to be a panel member. If countries decide to use HTS there should be precise guidance on how to do it.

EPPO diagnostic protocols: https://www.eppo.int/ACTIVITIES/plant_quarantine/diagnostics

Discussion: There are 32 diagnostic protocols under ISPM 27 and four have been added since 2019. Before that there were very few protocols that had molecular diagnostics. Out of the four added after 2019, three have a significant molecular component. This indicates that IPPC is adopting the use of molecular tools-based diagnostics faster. There are still very important steps to be done before these tools make it to standards and are used. No protocols use data from HTS technology yet because of challenges in data interpretation. HTS, data analysis, and interpretation need further work before being used.

General discussion: The challenge is to get the international coordination going. Is there a need for a coordinated effort, perhaps under IPPC, to help move towards integration, into management, and use in a regulatory framework?

Q: There is a lot of overlap in the diversity of fungi in soil with the work done on diversity of fungi in seed. Is there an overlap between people in IFQRG with the FAO organized group, the International Network on Soil Biodiversity?

A: They are probably both grappling with the same issues. It would be useful if they coordinate or work together as it is a complex issue. Link to FAO workshop on methods and metrics for soil biodiversity: https://fao.zoom.us/webinar/register/WN_5ggsvbxCRY29qBwJ-qJA2w#/registration

There are currently no intentions to combine groups or merge them. IPPC has some contacts with the soil fungi group but are currently just observing their work. There is also an FAO network for forest invasive pests, coordinated by Shiroma. Some discussions are happening at CPM and these points are integrated in the IPPC strategic framework until 2030. One such aim is an International Research Coordination. IFQRG could have an important role to play in that. In the next CPM we hope they will agree on terms of reference to put a focus group together on research coordination. As for diagnostics, there is another initiative starting on Laboratory Diagnostic Networking so the next CPM will also work on this group definition. There are a number of questions and discussion points to be addressed on organization, function, and endorsement, and how to better fit research into policy making, IPPC work, and standards.

Q: Molecular technology exposes the differences in technical capacity of the 185 contracting parties of IPPC. What percentage of those 185 parties are capable of using advanced molecular tools?

A: Scientists working on these tools should be encouraged to turn that technology into something that can be more widely used by a broader group of contracting parties, and that does not require sophisticated labs. If the technology is more available to more people, that would best serve the IPPC and trade. Some NPPOs may even have challenges with microscopy, let alone a molecular lab. There are organizations within FAO that can help countries that may have technical capacity challenges. Member countries are kicking in, running workshops etc., but it is still a great challenge for FAO.

The technology is becoming easily available and very low cost; however, interpretation and bioinformatics data is something that needs to catch up. We have to keep in mind that 70 % of contracting parties are considered developing countries. Those big initiatives on networks are designed to address some of these gaps. Some developing countries just outsource routine diagnostics, however there is still the challenge of what to do for first time detections, or routine surveillance that requires molecular tools. Analysis of data and interpretation from HTS is indeed challenging especially for policy making.

There is also the question of proving pathways and establishment of pests detected by molecular diagnostics. There are now a lot of guidelines on eDNA/RNA that are coming out, however guidelines are not standards. Canadian standards are the first and only national standards that exist. Certain types of techniques like HTS are not ready for standardization and need more work. However, qPCR methodology is ready and can be used. ISO is looking into this and planning to develop their own standards. There are technologies that can be implemented now by countries with less technical capacity. There are technologies that use isothermal approaches where you do not need fancy equipment to get results. These are low-cost technologies that can

be implemented in the field. In addition, alternative sequencing technologies like Minion technology (1000 US) is not expensive and error rates are continually becoming lower as the technology improves. They are cost effective and can be implemented by countries with less resources. Isothermal technologies can be very sensitive if you combine two different assays (two levels of specificity). For example, crispr based assays can detect into the attomolar scale if they are preceded by an amplification step.

The big discussion needed is what is considered a positive in cases of detection based on DNA or RNA in the absence of a physical sample. What do you need to accept that data? Do you require physical samples, or can we rely only on molecular diagnostics?

Scientists should also be able to better explain what they are finding. Something that may be of help to regulators, for instance providing the context of findings, or providing information that is easier to interpret. For example, what does it mean to find so many species of fungi in a small sample of soil? How do you interpret that information or use it?

Industry is directly affected by these developments. Sometimes they are too slow when needed and sometimes they are rushed. Nowadays we are all concerned with sustainability and the environment, and no one wants to be linked via trade to environmental disasters caused by pests that are carried on industry products. Sometimes it takes too long to implement something, especially new things that are shown to work.

Plant health Quads also actively work on diagnostics and should be part of international coordination efforts.

The annual IFQRG report to CPM could contain the major points from those discussions and that may lead to CPM recommendation. Several people from this group have shown an interest in participating in these developments. Perhaps something similar to the ISPM 15 guidance document could be suggested for molecular tools for consideration.

2. Phytosanitary Treatments – Day 2 – November 14th

Session Moderator: Ron Mack

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 Masters degree in Entomology, both from the University of Maine.

2.1 Update from the International Plant Protection Convention (IPPC) - *Kiss/ Peterson*

Authors: Janka Kiss and Barbara Peterson

Presenter Bios: 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. Barbara leads the Implementation and Facilitation Unit (IFU's) work on developing and managing IPPC Guides and Training Materials. She also coordinates the development of the IPPC Guides on Pest Status, Wood packaging material and E-commerce. She supports the Implementation and Capacity Development Committee teams on Guides and training materials, E-commerce and participation in the IPPC Commission on Phytosanitary Measures (CPM).

Discussion: A very thorough talk on IPPC organizational structure, standard setting and roles of participant groups. Of interest to this group are the various wood related standards, to include:

- Revision of ISPM-15 (Regulation of wood packaging material in international trade): Criteria for treatments for wood packaging material in international trade (2006-010), under SC consideration, priority 2.
- Use of systems approaches in managing pest risks associated with the movement of wood (2015-004) (Annex to ISPM-39: International movement of wood), consultation in 2023, priority 3.
- Annex to ISPM-28: HT of wood using dielectric heating (2007-114), objection, priority 1.

IPPC guidance documents and e-learning opportunities were discussed. There are also 2 treatment manuals under development. The first is Wood Packaging Material Heat Treatment Manual (2017-043a), and the second is Wood Packaging Material Fumigation Treatment Manual (2017-043b). The IPPC TPPT will be consulted regarding technical questions on these manuals submitted in 2023. IPPC hopes to publish these documents in 2024.

2.2 Food and Agriculture Organization (FAO) Forestry update - *Sathyapala*

Presenter Bio: Dr Shiroma Sathyapala, Forestry Officer FAO has been leading the Forest Health and Protection Program in FAO, Rome, Italy since 2014. Previously she led technical, policy, legislative and strategic work in the Ministry for Primary Industries (MPI) and Private Forestry Company New Zealand, and research institutions in Japan and Sri Lanka.

Abstract: FAO forest protection and health program 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.

In 2023, technical assistance to countries addressed issues on forest decline, chestnut blight, enhancing forest resilience towards native bark beetle outbreaks, invasive plants, invasive vertebrates and supported improving institutional capacities. FAO continues to facilitate the Forest Invasive Species Network activities in Africa, Asia and Pacific, Europe and Central Asia, south America and Near East. As part of regional activities, FAO completed an e-learning course on biological control of chestnut blight in Europe and central Asia. As global activities, FAO completed the review of Guide to implementation of phytosanitary standards in Forestry and created a new guide to support the development of national forest Biosecurity strategies.

Discussion: Attention was brought to the last slide, entitled "2025 At a Glance". Shiroma mentioned that this should have been the year "2024" instead for the initiatives that were listed.

Q: Is FAO involved in promoting the end of deforestation around the world, as well as endangered species protection?

A: Yes, in fact FAO is working on these things. Shiroma offered to provide more specific information on work in these areas if she is contacted.

A meeting participant mentioned that the effort around biosecurity sounds interesting, and I can offer assistance in any way that you need. Shiroma responded that FAO has selected a core group of participating countries, but they'd like to expand, and will contact you at a future date concerning participation and best practices. There are lots of questions in putting together a global framework, and I will be in touch.

Q: A question was asked on how global programming was influenced by Covid in last few years.

A: Shiroma discussed the difficulty of programming and praised webinars as a means to stay connected. Surveys were especially difficult to conduct.

Q: How were topics decided for the webinars?

A: Shiroma mentioned that groups would meet at the beginning of the year to put together an annual plan. What is considered most important at that time? Are there emerging pests to be concerned with? Each network has a secretary coordinator that makes the decision.

2.3 European and Mediterranean Plant Protection Organization (EPPO): an update on activities and invitation to collaborate in the field of quarantine forest pests – *Musolin*

Author: Dmitrii Musolin

Presenter Bio: Dmitrii Musolin, Ph.D., D.Sci., is a Scientific Officer of the European and Mediterranean Plant Protection Organization (EPPO) and coordinates the work of the EPPO Panel on Quarantine Pests for Forestry. Before joining EPPO in 2022, he was a Professor of Forest Entomology and Vice-Rector on Research and International Affairs of the Saint Petersburg State Forest Technical University, Saint Petersburg, Russia.

Abstract: The EPPO will be briefly introduced with the focus on the activities in the field of forest quarantine. Updates will be provided on the EPPO Global Database, Alert List, A1 and A2 Lists of species recommended by EPPO to member countries for regulation as quarantine pests. A recently established network of experts working on surveillance, monitoring, and control of *Agrilus planipennis* (Emerald ash borer) will be introduced. Experts will be invited to collaborate in the development of the EPPO Guidance document for managing the risks associated with international trade of wood chips.

Discussion: Based on your presentation, it appears that you keep lists of biocontrol agents in a database. Are these biocontrol agents approved for release in at least one country, or just recommended but possibly need more work on things like host range as an example? Dmitrii mentioned that there are two standards. One is for approved biocontrol species. Legislation differs between countries. A species of nematode was recently added to this list. The participant then brought up the idea that approval in one country would make it easier for other countries in the future.

2.4 Wood chips in global trade, market access issues and possible solutions – *Uzunovic*

Author: Uzunovic Adnan, *Canada Wood Group, Market Access and Trade - consultant*

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 a 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.

Abstract: Ongoing surplus of wood chips in some countries and growing needs for chips in other countries creates urgent need to move these chips to international markets. Imports may be severely restricted due to phytosanitary concerns and lack of economical and agreed pest management options. The talk will discuss the risks in the context of science-based solutions that aim to be economical and least restrictive to trade while having in mind the variety of chips, sources and processes, existing codes and regulations, knowledge of pests and pathways, and existing and potentially new management and treatment solutions.

Summary: A thorough analysis on wood chips in trade that covered - basic definition of chips, market dynamics, and risk. A nice example was provided on how the debate and agreement over bark on WPM between regulatory authorities, industry and interest groups could inform an acceptable arrangement for international chip import/export that supports trade and lessens phytosanitary risk. Pest risk in theory versus reality was discussed at length.

Important thoughts from the presentation:

What do we need to discuss?

1. What is the significance of potential presence of any live pests in chips?
2. What is the significance of presence of bark on chips (presence of pests/potential for reinfestation)? Is this important in real life?
3. What is the potential of establishment and pathway in a real-life situation?
4. Which measures/treatments are most feasible and technically justified for this low cost commodity?

Potential way forward?

1. Agreement that chips are a low-risk commodity (based on science on pathways and establishment in a real life situation), or agreed upon position by international group of knowledgeable peers
2. A risk-based approach considering processing specifics (e.g. mechanical chipping and size) and end use (biofuel, pulp and paper, etc.) under compliance agreements at origin and destination. Systems approaches used to reduce low risk to even lower risk (controlled source, storage, timing, documented use at the source, specified handling, use chips of certain size and moisture, inspection before shipping, moving chips only in winter, use wood from pest free areas, and other best management practices).
3. Are treatments most likely not feasible for chips as a low-cost commodity? Fumigation with EDN may be a possibility if cheap enough.
4. Possibility of conversion to wood fuel pellets for export (Pros: no phytosanitary issues due to high heat and pressure used; wood in densified form is more economical and easier to ship. Cons: need to develop sustainable pellet industry production).

2.5 Heat treatment of wood chips: no need to reinvent the wheel! – *Henin*

Author: Jean-Marc Henin

Presenter Bio: Jean-Marc Henin is a Forest engineer graduated from the Faculty of Agronomical Sciences in Gembloux (Belgium). Since 2007, he has been working in the Laboratory of Wood Technology (Walloon Agricultural Research Centre) where the group develop and research the impact of sylvicultural practices on wood properties, and on the functioning of the forest-wood chain, as well as on phytosanitary and preservation physical treatments applied to wood products. In previous experiences, he has worked on the management of some forest pests (notably bark beetles) and on the ecology of their populations.

Abstract: Relying on solid experimental basis and in-depth scientific expertise, HT (56°C/30 min as defined in ISPM15) is applied daily to Wood Packaging Material (WPM) all over the world, with unquestionable effectiveness in reducing phytosanitary risks!

As overseas wood chips annual trade represents tens of millions of bdt, an industrial dryer was used to assess the efficiency of HT on wood chips contaminated with larvae of the old house borer, *Hylotrupes bajulus* (L.) (Col. Cerambycidae). For both ranges of moisture content and temperature tested, all the insects, despite their high heat-tolerance, were killed by the treatment. Together with other scientific evidence, these results suggest that, as for WPM, it would be advisable to approve the combination 56 °C/30min as a phytosanitary treatment for wood chips.

Summary: A series of softwood chips that were seeded with thermotolerant old house borer larvae were inserted into a stream of wood chips that were conveyed through an applied heat treatment (95 °C for 40 total minutes) to a 56 °C/ 30 min exposure target. A test matrix of varied chip moisture content (<50% and >85%), initial temp (5 °C and 20 °C) resulted in 100% mortality over the course of 8 trials (22 insects per trial). A number of observations and assumptions were made by the author in support of 56 °C/30 min HT as a quarantine treatment of wood chips.

Discussion: A comment was provided on the natural heating of chips in piles. This concept was illustrated in a slide depicting a layered approach to chip treatment in a ship's hold. Jean-Marc claimed that the bottom layer of chips would benefit from heating due to natural biological processes. The commenter pointed out research on bark pile composting to eliminate PWN, which was presented at prior IFQRG meeting in Cardiff, Wales. There were many temperature probes in that study, and target temperatures were not achieved satisfactorily. Jean-Marc replied that bark would be fundamentally different from wood chips in heating habit, so that results should not be expected to be the same.

A similar composting test was accomplished in the UK with wood chips. Also, Portugal was mentioned for its work on steam treatment of wood chips using conveyor belt. A commenter with knowledge of the Portugal experience explained that a study on heating in bark piles created chimneys in the pile through natural fermentation. The pile was probed in 100 locations, but target temperatures were not reached in all locations. The feeling is that heating through composting could work substantially, but a strict mixing plan would be required.

The rest of the discussion was deferred until the general discussion at the end of the day.

Research needs:

1. Further work at real commercial scale. There was no mention of throughput in this experiment, even though it was referred to as industrial scale. It appeared to be less than what would be expected of a true industrial scale.
2. Additional work on PWN and other pests/pathogens at commercial scale.
3. What are additional requirements for a successful treatment that could be certified? Would preheating in colder climates be necessary, and how would this be accomplished. How would temperature monitoring be conducted?
4. Energy use data at scale. Would industry consider this?

2.6 Preparation of an EPPO guidance document for managing the risks associated with international trade in wood chips - *Tassus*

Authors: Tassus Xavier[1], Henin Jean-Marc[2], Uzunovic Adnan[3] and Musolin Dmitrii[4]

[1] *ANSES Plant health laboratory, Expertise and Biological risk unit, France*
[2] *CRA-W, Laboratory of Wood Technology, Belgium*
[3] *Canada Wood Group, Market Access and Trade - consultant*
[4] *European and Mediterranean Plant Protection Organization (EPPO)*

Presenter Bio: Xavier Tassus, Msc., is a scientific officer of the ANSES (French Agency for Food, Environmental and occupational health), Plant health laboratory (Angers). Since 2012, he has worked in a team in charge of the risk assessment in the domain of plant health. In particular, he coordinates the working group in charge of the risk assessment of the pinewood nematode and of new technologies of wood treatment in the framework of the ISPM 15. He is also a member of the EPPO panel of the quarantine pests for forestry.

Abstract: International movements of wood chips amount to millions of tonnes per year, posing a non-negligible risk of biological invasions. The EPPO guidance document under preparation aims at identifying factors affecting the phytosanitary risks associated with trade of wood chips. It will take into account the chip's origin and characteristics, production process, storage, transport conditions, and intended use.

The document will further assess how these factors can be mitigated/managed, including systems approach in order to reduce the identified risks without a disproportionate impact on international trade in wood chips.

Discussion: Is the steam treatment of wood chips happening on a commercial scale? A commenter from Portugal claimed that they have used the steam treatment on bark and wood chips for consignment to Turkey. It was used only once, but apparently worked 100%. He claimed it was not an issue to treat bark or wood chips. It's already approved for use on bark. We'll get into this further in the general discussion at the end of the day.

Another participant brought up the power of the contract. Chips are often high quality and specified by contract, and if you don't meet those quality standards, you don't get paid. Incentivized so that the producer must provide quality. The other thing to mention is the regulatory approval that goes beyond phytosanitary measures. By controlling chain of custody in a very tight way, you could mitigate risk through chain of custody control. Examples include blocking vents of container/ship, moving chips directly to another country and immediately into the digester. Control through contracts and chain of custody/safeguarding measures has merit for certain commodities, including chips.

A comment was directed at a statement on one slide that said systems approach measures reduce pest threat. Commentor pointed out that some measures could be designed for monitoring as an example and may not have much bearing on reducing pest threat.

A comment on Canada chip export. As an industry association in Canada, they have investigated the possibility of exporting high quality wood chips. Heat treatment technically works. Money side, meaning economics, didn't work out. They have experience exporting fumigated chips to Turkey (phosphine treated). Looking at company costs, heat treatment of chips was 5x more expensive. For a low value commodity, it seems unrealistic to conduct heat treatment on chips. Another factor is the changing character of the market. Markets come and go. There is a chip surplus at times. Heat treatment is a significant investment. The more realistic option then is fumigation.

What is known of fumigants that could be cost effective for chips? A commenter brought up that phosphine was becoming more difficult to use. Not really efficient for PWN and pathogens in chips. Better for insects. SF may only be a temporary solution due to greenhouse gas concerns. EDN is promising, and it's currently being evaluated. Cost is key. Will it become available and

registered, and how costly will it be? If EDN is similar in price to MB and Phosphine, EDN could be used. It's efficient against PWN and pathogens as we know. They also have a satisfactory delivery system in these large ship holds.

A comment was made regarding heat and the potential of cheap heating sources. Some 20 years ago, NZ looked at the feasibility of using heat. If you can find a cheap source of heat, it could work. Geothermal, sugar mill production are possible cheap heat sources. If for example you could combine chip treatment interest with a sugar mill in some way, it could be cost effective.

A comment on the EPPO guidance document for chips. The process that EPPO started is a great one. They are trying to come up with guidance on how to use this. There are many elements ongoing that favor chips. The heating may not be a standalone treatment, but it could be part of a systems approach. IFQRG is encouraged to be involved. A group of knowledgeable peers can come up with a recommendation that we can live with. NAPPO could have involvement with this.

Q: A question on whether fumigants face the same issue of penetration throughout the chip load as heat would?

A: A commenter suggested that a good fumigant with a better delivery system would have better penetrating ability and would be easier to deliver. Another commenter mentioned that conveying while treating would make chips more available to treatment versus treating in a large pile. Fumigant delivery lines need to be placed properly for successful fumigation. Some fumigants going into gaseous phase can push through a chip load adequately. Opinion on this is based on experience with EDN development in AU. The silo system used for grain fumigation is perhaps instructive for chips. Distribution through an established circulation system would need to be accomplished. With phosphine, you can drop tablets as chips are loaded, as is done with grain.

Research/Administrative Needs

1. Feedback from all RPPO's, NPPO's and stakeholders that received the data collection questionnaire. Best response leads to better implementation and perhaps EPPO standard for wood chips.
2. Consider proposed annex to ISPM-29 for guidance on systems approach development for wood chips.

General Discussion: Moderator opened the general discussion by asking for any questions on the update talks that were presented. A comment was made on how thorough the IPPC talk was, and how the work that the IPPC is conducting connected very well with what IFQRG was doing.

Q: Question for Barbara: As part of the process of completing the treatment manual, after you work through answering all the technical questions, does it have to go through another

consultation, or is that final Guides and training materials are different from standards in that they aren't adopted by the Commission.

A: Standards all need to be adopted by CPM. Guides and training materials are developed by working groups, then they go for peer review. Once finalized, they are edited. Approval is done by the IC lead for the project.

Q: A question on the IPPC Call for Topics generally. Confusion on whether Call for Topics can be submitted at any time.

A: Janka mentioned that the call for phytosanitary treatments is a separate call from call for ISPM's. The call for ISPM's is only open every second year. The call for phytosanitary treatments is always open.

A comment was made regarding wood chips, and if there was a good treatment, it could be put forth as part of treatment topics. Janka agreed.

Q: A question on how far away was ISPM-15 guidance from publication?

A: Barbara mentioned that it would be in the first half of 2024 for sure. It has to go through a rather involved FAO publication process.

Q: A question on the approval process for steam treatment of bark submitted by Portuguese authority.

A: Janka responded that the proposal is being prepared, but not yet formally submitted to her knowledge. The hangup is the need for research data to satisfy ISPM-28. Apparently, there is information provided on how to treat, but not sufficient numerical support data. The question submitter then mentions that the bark treatment with steam initiative extends back 10 years, and that many EU countries in EPPO already accept the treatment.

Q: A question on details behind the objection to ISPM-28 for dielectric heat treatment of WPM.

A: Janka mentioned that this has been an ongoing objection since 2016. Basically, waiting on some implementation guidance before continuing to address the objection. When the new dielectric treatment schedule was added to ISPM-15, it was also proposed to become an annex to ISPM-28. The ISPM-15 category allows for application of the mark, and ISPM-28 was for wood in general. An objection to ISPM-28 was placed weeks before the meeting by a contracting party that had difficulty with heating uniformity and nematode survival post dielectric application on oversize timbers. There isn't experience with this treatment, and not enough guidance on how to apply it properly. The Standards Committee basically said let's wait for some implementation guidance, then consider adoption at that time.

Q: Another question on dielectric heating. This one concerns the schedule 60 °C/1 min hold and whether the schedule could change based on implementation guidance that could be forthcoming?

A: A participant related experience with dielectric RF heating and temperature monitoring. None of the participants knew whether the 2016 objection was microwave or RF, which would be important to understand. Janka reiterated that the schedule is good, just need to sort out operational details. A comment was made by a RF research team member that they were well on their way toward describing operational RF for bulk WPM treatment, with a paper near completion. This led another participant to mention that further discussion on treatments and TPPT would be presented on day 3 of the IFQRG meeting.

Q: The group shifted back to a general discussion on chips and the three chip related talks that were presented earlier in the day. Adnan mentioned that EPPO will continue working on the guide for chips. Perhaps the guide will get approval from EPPO. If a treatment for chips is approved, then great, but if not, then guidance is key. What are the key steps or knowledge gaps that this group could outline that would allow for chip movement through use of a systems approach? Should we wait to see what EPPO comes up with first?

A: Dmitrii suggests that he'd like input on the document as soon as possible. It may or may not become a regional standard. A participant asked Dmitrii if he could comment on any feedback that you've received in developing the document? Did anyone respond that already has some level of system approach in place? Dmitrii responded that he wasn't sure how to engage countries for input, so they sent a letter to gauge interest. Canada has been helpful in refining the questionnaire. He hasn't heard back from a lot of countries at this time. Still in the initial stage of the project, and he'd greatly appreciate any input from this group.

Q: A question on risk assessment of chips and trade flow that was presented earlier. An early PRA was done for PWN that resulted in chips being considered low risk. Then the idea of using chips for landscape and horticultural practices, like use on footpaths, caused a rethinking of risk. Is there any information on the amount of chips for this kind of use? Would chips for fuel production be diverted to other uses? Another comment/question by this participant suggested that a systems approach begin and end in the exporting country. The importing country should have this burden removed.

A: Adnan appreciated the comment and continued on with thoughts on finding a solution to allow chip movement. What are the minimal steps that need to be accomplished by importers and exporters? Are there portions of trade to safely allow? And what are the key elements of safe trade? He also suggested that natural heat treatment (composting) of chips in piles has benefit that should count. Another participant singled out the concept of cost effectiveness with regard to heat treatment of chips and why this should be looked at with more balance. The overall trade of chips may in fact be of higher value to industry if we consider aspects beyond just the buyer.

A comment was raised on the approach that we've historically taken on treatment for pests in the forestry sector. There are notable differences between horticultural sector and forestry sector with regard to treatment approaches. An example was given for fruit flies and mango. Maybe we should borrow a page from the horticultural sector and consider treatment of a particular pest or

pathway instead of an all-inclusive approach. That way you build a suitable library of treatment options over time. Our present approach to treatment in the forestry sector is slowing us down.

A comment and an agreement that HT would be great to have as a basic solution. When discussing systems approach, it is easier on high grade chips that would have less complication with contaminants. Energy sector would have the lowest quality chips, so perhaps it is harder to institute a suitable systems approach there.

A comment that a systems approach is typically done for a single pest of known biology. You know the production steps, so you can proceed in a certain way.

Q: A question on whether a dry heating process would make high grade pulp chips less desirable?

A: A participant claimed that yes, in fact this would be a major concern for industry.

Q: A question on whether anything has been published on chipping forces (e.g. accelerative, concussive) other than the knife action on pests in chips.

A: A participant responded that a paper was in progress that detailed these impacts on ALB mortality using commercial 12-inch drum and disc chippers. It was hoped that additional data using large woodchippers would be added.

The risk of PWN in pine shavings was brought up, with reference to a paper that documented PWN moving from shavings to live trees. EPPO has made a statement regarding risk on this topic. In response, a participant mentioned that presence of small pieces of bark can assist reinfestation, but in real life, the risk is likely very low. He further suggested that this should apply to shavings in real life.

Janka mentioned that the proposed annex to ISPM-39 (International movement of wood) has a section on systems approach that could help with the development of systems approach for wood chips. It is not an adopted standard at this time, but a draft went to consultation in 2023. The Standards Committee will review, then there will be another consultation.

The topic of end use consideration was brought up with regard to heat treatment for chips. There's considerable carbon expense with heat treatment. Perhaps we could pursue an option to keep carbon cost down while still providing an acceptable level of protection. Another participant agreed very much with this thinking. He provided the example of wastefully continuing to HT pallets with low moisture content. Let's look more closely at this and cut down on carbon footprint.

A final thought on caution around ISPM-15 HT standard and use of the 56 °C/ 30-minute schedule for experiments with wood. We heard earlier today on use of 56 °C/30 min for use on chips. The data presented in that case was supportive, but there have been presentations in previous years using roundwood with bark on that were reported as ISPM-15 failures when pests survived. The ISPM-15 HT standard has very specific language on the kind of wood applicable to the standard, and as presently written, these test cases do not qualify under the standard.

Heating dynamics vary considerably between sawn lumber, round wood and chips. Failure due to pest survival in wood type/configuration that is not described under the standard should not be considered a legitimate challenge to the efficacy of ISPM-15.

3. Phytosanitary Treatments – Day 3 – November 21st

Session Moderator: Eric Allen

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), member of the North American Plant Protection Organization (NAPPO) Forestry Panel and expert groups on Forestry Systems Approaches and Contaminating Organisms and the International Plant Protection Convention (IPPC) Technical Panel on Forest Quarantine (TPFQ). 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 teamwork and collaboration through bringing global experts from science, industry and regulatory communities together to solve phytosanitary issues in forestry.

3.1 International Plant Protection Convention – Technical Panel on Phytosanitary Treatments (TPPT) update – *Ormsby*

Author: Mike Ormsby

Presenter Bio: Dr Mike Ormsby is the Principal Adviser of the Office of the Chief Biosecurity Officer, Ministry of Primary Industries. He has for many years managed a team of scientists in the New Zealand Ministry of Primary Industries to assess pest risks to New Zealand and oversees research programs to support pest management. Dr Ormsby has worked in the phytosanitary area for over 25 years and has been a member of IFQRG and the IPPC technical panels for treatments and forest quarantine since 2005.

Abstract: The Technical Panel on Phytosanitary Treatments (TPPT) evaluates data submissions from National and Regional Plant Protection Organizations and reviews, revises and develops phytosanitary treatments. This group also provides guidance to the Standards Committee regarding specific phytosanitary treatment issues. The TPPT evaluates treatment submissions against requirements in the International Standard for Phytosanitary Measures ISPM 28 – Phytosanitary treatments for regulated pests. An overview of the submission process, need for phytosanitary treatments and the current status of PTs will be provided.

Discussion: The TPPT website is open to everyone with information on submissions and current treatments: https://www.ippc.int/en/commission/standards-committee/technical-panels/technical-panel-phytosanitary-treatments/

Q: A question regarding why there is a difference between ISPM 15 and ISPM 28 treatments.

A: In ISPM 15 there is guidance on how to apply a treatment. ISPM 28 outlines how to kill the pest and doesn't describe how to apply a treatment. ISPM 42, 43 and 44 (*Requirements for the use of…)* have the information on the implementation: https://www.ippc.int/en/core-activities/standards-setting/ispms/**.**

Another comment was made regarding the shift in thinking regarding treatment submissions which is positive. Rather than trying to develop the information required to support a treatment for a particular commodity such as wood, the initial focus should be to develop and submit a treatment schedule for a single important pest associated with the commodity. This is the approach most treatment methods have taken. Irradiation treatments were submitted for single pests in fruit before later getting approval for whole families of pests. The initial approvals gained confidence that the treatment would be viable in trade, was soon followed by countries approving the use of irradiation in international trade and resulted in more countries investing in developing schedules for the treatment.

It was also noted that treatments developed for other commodities other than wood can use different approaches to overcome practical issues. The development of a heat treatment in wood demonstrated that 56°C for 30 minutes would kill pests in wood, but left regulators and treatment applicators to develop heating schedules for different sizes of wood to ensure the pest within received the required dose of heat (56/30). Separating the dose required to kill the pest from the schedule required to ensure the pest receives that dose in different thicknesses of wood ensures that when pests survive in trade NPPOs would be more assured that the failure was more likely a failure to apply the treatment correctly rather than a failure of the dose.

3.2 Alternatives to methyl bromide - Update on the research and registration status, relevant working groups and options in 2023/2024 – *Uzunovic*

Authors: Adnan Uzunovic, Mike Hall, Mike Ormsby, Ron Mack, and Ken Glassey

Presenter Bio: Matt currently works as the Head of Phytosanitary & Market Access Affairs for Draslovka Services, focusing on the global acceptance of environmentally sustainable fumigants for the treatment of goods in international trade. He has over fifteen years of experience managing industry-funded research programs and has completed his bachelor's degree in Agricultural Science and PhD in Horticulture at the University of Sydney and his Master of Business Administration at Griffith University. Matt is also an Adjunct Associate Professor at

Central Queensland University (CQU), where he contributes to the Institute for Future Farming Systems.

Abstract: Fumigation is a very important phytosanitary treatment/measure in the global trade in forestry and other commodities. Methyl bromide (MB) that has traditionally been used for years, is an ozone-depleting substance and destined to be phased out for non-quarantine and pre-shipment (QPS) uses through the Montreal protocol which has been hugely successful as only 3 tonnes use remains, down from 70,000 tonnes. However, recent data suggests QPS use of methyl bromide, though excluded from the Protocol, QPS has remained the same at around 10,000 tonnes. A moratorium on MB use by some countries has created a trade imbalance, furthering the need for suitable alternatives. Numerous alternatives have been tested over years and some adopted, with Phosphine and Sulfuryl fluoride (SF) being the most promising until the issues of inefficiency were recognised as well as SF being potent synthetic greenhouse gas itself with significant global warming potential. Currently Ethyl formate has been evaluated as great option for surface pests while Ethanedinitrile (EDN), which has gone through extensive scrutiny and research in the last decade, appears to be currently the only economically viable and environmentally benign true alternative to MB and SF, highly efficacious against numerous pest types particularly for wood commodities which comprise the highest proportion of MB QPS uses. There are other potential uses where MB could be replaced (horticulture material, perishables, hay, soil, equipment…). This paper summarizes the current situation with the two fumigants and challenges in the regulatory world and possible ways forward.

Discussion:

Q: A question was asked regarding how EDN compares to MBr cost wise.

A: MBr rates are lower, using less substance which makes it cheaper. The major issue with EDN cost is that it is not currently stored and transported in high pressure cylinders like MBr. EDN uses more contemporary cylinders appropriate for the substance.

Discussion regarding the groups currently working on alternatives to MBr: IFQRG, QUADS MBAWG, NAPPO EG, IPPC. What other relevant groups exist? Ozone Secretariat?

Industry noted that alternative fumigants are urgently needed for wood products exporters, especially in those countries that are actively restricting the use of MBr.

Discussion regarding registration and the order of steps to take noted that regulatory bodies only start working on registration applications when the company asks for registration in the EU.

Q: One of the outlining questions regarding EDN concerned environmental considerations - a question was asked regarding a review paper on this subject.

A: There is currently research ongoing under Keith Shine in the UK - defining the global warming potential of a number fumigants including SF, HCN, EF and EDN: (https://iopscience.iop.org/article/10.1088/2515-7620/acd511/meta.

Q: A question regarding whether there is an ISPM covering bamboo or the use of MBR alternatives for bamboo. There was a potential Euphresco project specifically aimed at bamboo and wood chips and other wood products but it is not occurring.

3.3 Commercial-scale validation of the efficacy of ethanedinitrile against the sirex woodwasp (*Sirex noctilio*) in naturally-infested pine (*Pinus radiata* D.Don) wood – *Hall*

Author: Matt Hall

Abstract: Log stacks (151.4 ± 8.8 g m^{-3}) were fumigated at ambient temperature with an EDN dose of 100 g m^{-3} for 24 h. The average concentration x time (CT) value for the three replicates was 844 ± 127 g h m^{-3}. The control had a total of 1,028 emergence holes, while fumigated replicates had 4, 7 and 17 emergence holes. Therefore, the average mortality, based on the measured emergence of the control, was 99.09 ± 0.38%. In addition, twenty-five naturally infested billets from each log stack were scanned using computed tomography; extrapolating these results provides a mortality estimate of 99.55 ± 0.19%.

Summary: The presentation showed that these types of studies are conducted to support market access. The author's group is working on registering EDN in a number of countries. The study organism, *Syrex,* was chosen because it is a deep wood borer that is assumed to be difficult to control. There are biological controls such as nematodes and parasitic wasps however even at reduced populations levels trading partners are concerned with this pest.

10-12% of the billets were CT scanned to locate individual insects in the wood and estimate the number of larvae per billet (logs). PCR was used to confirm the identity of the organism -*Syrex.*

Discussion:

Q: If EDN disappears after 12 hours why are the schedules for 24 hours? A: Restrictions on venting at 700 ppm which allows the fumigant to be at low concentration.

Q: With MBR fumigant is still in the wood days after fumigation and venting. Does EDN stay in the wood?

Q: Can insects reinfest after treatment; would the wood be attractive to insects during transport? A: Possibly but this pest will only attack and infest a living tree therefore logs would not be attractive.

It was noted that other pests that infest dried wood may be attracted. ISPM 15 treatment cannot have toxic residues in the wood because it may be used as firewood in developing countries. There is a narrow range of pests which infest dead and dry wood. Most ovipositing beetles that lay eggs on bark look for healthy wood of a certain quality.

Q: There were *Syrex* adult survivors that emerged from treated bolts in this study. Do those survivors reflect the efficacy of the fumigant or its ability to penetrate the bolt, e.g. were the surviving *Syrex* those that were deepest in the wood? A: Efficacy of the treatment and its ability to penetrate are linked. We didn't present the information showing that the adults that emerged were in the wood located at the front of the stack, where it was windy, this may indicate an issue with sealing. Researchers also measured CTs showing that they were lower at the front of the stack. The insects move readily through the wood thus it's difficult to pinpoint location or depth in the wood at the point of treatment - some are deep in the wood and some at the surface.

It was noted that with MBr, the effective dose for soft bodied insects is approximately 60 CT with direct exposure, for beetles - 80 CT, and most tolerant stage for BMSB (diapausing adults) - 110 CT. Survivorship is usually due to a mistreatment issue or a penetration issue. The situation might be similar for EDN. For treatments submission data, it seems we are challenging ourselves to develop schedules that deal with commodity penetration, however other treatments don't do this, instead they only calculate the dose for mortality with direct exposure. In the Syrex study, survivorship was likely due to the type of application not effectiveness of the fumigant. In direct exposure it would be effective.

The author noted that current work on fumigating in containers is more controlled. In the forest where they fumigate large stacks it's more difficult to control.

3.4 The Canadian shipborne dunnage program – *Frechette*

Author: Hugo Frechette

Presenter Bio: Hugo has now been with the CFIA for over 15 years. He has held several positions in plant protection operations and has been part of the forestry programs section for almost four years. He was responsible for revising the wood packaging material directive and developing the new shipborne dunnage program.

Abstract: The introduction into parts of North America of the Asian longhorned beetle (*Anoplophora glabripennis*), brown spruce longhorn beetle (*Tetropium fuscum*), emerald ash borer (*Agrilus planipennis*), and other exotic pests can now be linked to international shipments containing wood packaging material (WPM). While ISPM 15 addresses the WPM pathway, shipborne dunnage, a type of WPM, continues to pose challenges due to a higher number of

unmarked, untreated or unverifiable pieces. In order to mitigate the risk of pests associated with non-compliant dunnage, the CFIA has established in 2023 a new shipborne dunnage program providing specific requirements for the safe discharge and disposal of shipborne dunnage in all ports of Canada.

Summary: The presenter discussed the translation of scientific knowledge into enforceable rules or in this case into an applicable program. The presentation covered the new shipborne dunnage program in Canada, how it was designed and the scope.

The definition for shipborne dunnage used in the presentation was: 'dunnage brought into Canada by marine vessel and disassociated from the commodity at the port'.

Massive volumes of dunnage are used on ships. In Canada it was considered discharged waste with no owner. It is difficult and unsafe to inspect this type of WPM. Issues to solve included where dunnage was discharged, who owned it, how to sort compliant from non-compliant dunnage. D-98-08: https://inspection.canada.ca/plant-health/invasive-species/directives/forest-products/d-98-08/eng/1323963831423/1323964135993

Shipborne dunnage may only be discharged in approved terminals. Ships discharging must notify the NPPO in advance for inspection. There are high and low risk periods and definitions of these periods are different across Canada according to climate. All dunnage must be disposed of and treated in an approved facility. There is a plan to upgrade the program in the future to manage compliant material. A program was designed with a plan to implement measures and collect data.

Discussion:

Q: How would you compare the risk profile of dunnage to other forms of WPM?

A: Dunnage is higher risk, it comprises loose pieces, not crates, pallets etc. Dunnage also is considered higher risk because it is not made of higher quality material as pallets and crates are.

Q: In the US they have been tasked with looking at different disposal method options. Where ports had issues incinerating, due to clean air restrictions they investigated options such as mechanical destruction, e.g., hammer mill and chipping/ grinding.

A: In Canada, mechanical destruction was not considered sufficient. In the past they chipped to 2.5 cm in two dimensions. This was fine for EAB but not smaller pests, therefore chipping must be followed by another measure such as incineration. Movement restrictions or storage once chipped were included in guidelines/ regulations. Regarding the hammer mill process, if there was an application for this treatment submitted and it was proven safe, it would be accepted, but they haven't had applications yet. They are happy to review new options submitted.

Q: Who pays for treatment of dunnage?

A: Industry/ those considered responsible

3.5 Evaluating the risk associated with different categories of wood packaging material - *Noseworthy*

Author: Meghan Noseworthy/ Eric Allen

Presenter Bio: Meghan Noseworthy works for the Canadian Forest Service of Natural Resources Canada as the research manager of the Forest Phytosanitary Research Group. She is the Secretary of IFQRG and the NAPPO Forest Quarantine Research Group, a member of the International Plant Protection Convention (IPPC) Technical Panel on Phytosanitary Treatments and Chair of the expert working group for the draft annex on systems approaches for wood commodities to ISPM 39, *The international movement of wood*. In her spare time, she conducts heat treatment research at the Pacific Forestry Centre.

Abstract: Since the implementation of the International Standard for Phytosanitary Measures (ISPM) 15, the incidence of pests moving on wood packaging material (WPM) has been greatly reduced. However, pests continue to be intercepted on this pathway, which is a cause of concern for many stakeholders (National Plant Protection Organizations, science, industry and NGOs). A better understanding of whether pest risk is consistent across the different types of wood packaging (pallets, crates packaging cases, cable drums, dunnage) would help focus mitigation efforts. The North American Plant Protection Organization has organized an expert group to develop a science and technology document which will improve both our understanding of the challenges associated with different categories of WPM, recommend risk reduction strategies and best practices the different sectors have developed to improve ISPM 15 compliance.

Summary: An overview of the project scope was given and a description of what is lacking: i.e. definitions, descriptions of production processes, level of oversight and coordination for different categories of WPM. Consideration for differences in the risk associated with different categories of WPM, e.g. dunnage and what the possible factors which may explain these differences are, such as the level of processing, standardization, size etc. The project will draw from previous research and guidance such as the new *ISPM 15 Guide to the regulation of wood packaging material: Understanding the phytosanitary requirements for the movement of wood packaging material in international trade* (https://www.fao.org/documents/card/en?details=cc5059en) as well as look for expertise in the industry and data available from NPPOs. The project aims to provide a technical understanding of the challenges associated with high-risk WPM, improve compliance with ISPM 15 guidelines, and target high risk WPM to reduce pest movement.

Discussion: Do you know if the interceptions are dry wood borers that may have infested the dunnage after ISPM 15 treatment or living tree pests that ISPM 15 targets? A: Current data

doesn't always differentiate what type of pest (infesting, contaminating or number of individuals, live/ dead) or what type of WPM has been non-compliant. It's important for us to make these distinctions because ISPM 15 only targets living pests and doesn't address contaminating pests or post-treatment pests. Understanding this will help us to better focus our attention.

Q: One of the problems with use of WPM that is ISPM 15 stamped compared to other shipping methods like containers that are treated (e.g., closed box with a chain of custody, e.g., with fruit or treated commodities for BMSB) is the regulation of the ISPM 15 mark which may be reused/ repaired or is possibly used fraudulently. In this case if a pest is found it may be difficult to traceback, thus deregistering a facility or treater is difficult - doesn't fit the normal regulatory-response model of being able to react when there is a problem.

A: This has been a challenge of ISPM 15 from its inception or adoption. It is a material which moves in association with commodities with an ongoing lifespan globally. A number of attributes associated with WPM result in it being outside the realm of the regulatory inspection process for pests, this is one reason we are still talking about it and facing challenges today.

Q: Through a traceback system you can trigger an investigation to a provider and sometimes you find out that they are stamping and selling ISPM 15 wood which hasn't been treated (HT). Some operators can be found the system needs to be able to do this traceback.

A: We do continue to get pests and we continue to look for causes. Bob Haack's work on WPM interception data in the US discusses causes, e.g. we don't have treatments right, haven't applied them correctly, or fraud has occurred. We need to look at what is going on and what we can or can't do while taking into consideration the diminishing returns on the things we can't control.

We need a global perspective on this. What can be done in more developed countries with organized regulatory agency oversight may be different than what other contracting parties can do who don't have good communication with their NPPOs or regulatory oversight over industries or shipping. Thus, we must consider the big picture. The resolution must incorporate this larger picture. The NAPPO group must consider this challenge with a global perspective.

With good information on the higher risk categories, we can look to the new ISPM 15 guidance and possibly follow up with workshops and share what we find with the rest of the world. We know dunnage is more problematic, but we need some numbers to sort out the risk. Data collection and consistency parameters are outlined in the new ISPM 15 guidance document so going forward we can compare data in a meaningful way.

Additional General Discussion: It would be good to have an overview of the fumigants currently available for wood products and what their status is currently. A description of this might be appended to the proceedings of the next meeting (Adnan Uzunovic action item for 2024).

Wood product treatment submissions:

- Discussion regarding the idea of treatment submissions for wood products included the idea of decreasing the level of complexity for wood product treatments in order to submit treatments with the data available by species for example. Much like irradiation treatments for fruit flies in ISPM 28 these may eventually be concatenated to one treatment for a genus when an overarching treatment is effective across a genus.
- Under ISPM 28 treatments are outlined according to efficacy and specifications for dose are provided. Other guidance including other ISPMs provide information on how to apply treatments. The TPPT does not have a role in the latter. The MBr dose recommended for the most tolerant insect is 110 CT, in ISPM 15 however the recommended dose is 600-800 because it is penetrating wood. This is appropriate for ISPM 15 but not for ISPM 28.
- Regarding the appropriate number of individual wood pests for a treatment efficacy for new treatments was mentioned and will be discussed on Day 4.

EDN

- Discussion on limitations to registration of EDN and other fumigants included clarification on the processes ongoing for registration application and other factors limiting current processes.
- To summarize what is needed for the EDN application - monitoring the fumigation and CT value. Perhaps describing the volume of EDN to a product for a time may be what should be described.
- EDN has a high rate of sorption thus CT measurement is challenging. Peer reviewed publications require a high CT. Commercially they will measure start, middle and end and the CT will be much lower. E.g. 844 study but in commercial 140 CT. Is CT the correct model, I don't know.
- HT doesn't use CT. Not heat over time. Some treatments don’t use CT.

ISPM 28 treatments

Q: Regarding the use of treatments in a bilateral agreement, how does this differ from ISPM 28 adoption of treatments?

A: WTO is about multilateral trade, IPPC is about protecting forests internationally, ISPMs are about multilateral trade and can be applied bilaterally. The TPPT works to approve treatments under ISPM 28 that are being used already, just need one example in use commercially. The level of efficacy may be more than is needed. ISPMs are guidance documents, they give contracting parties more confidence that treatments work. The efficacy number isn’t a maximum; it reflects the number of insects that were exposed. The efficacy could be higher. There are many dimensions to it, and it is a complex area.

The other level to this is to recognize the regulatory environment in a particular country which determines what is accepted.

Dunnage and WPM

Q: Containerized dunnage offloaded and discharged away from the port is not a part of the program?

A: Any dunnage on the ship or dissociated at the port are part of the program. The current focus is made where the highest risk seems to be. With the data collected they hope that better enforcement will be possible.

Contractual requirements rather than regulatory oversight may be more effective for ensuring the use of compliant material occurs.

Recommendation on WPM risk

To get information on the actual risk of the different types of WPM look to NPPOs for data on NNCs where mass emergence has occurred. Only one instance where WPM with mass emergence occurred in 7 years of regulatory imports in Australia noted (*Monochamus*). There could be data that indicates which types of commodities or circumstances are associated with higher risk WPM. Most often infested WPM cases are single pest finds. However, cases where WPM accumulates in one spot are likely candidates for high-risk situations, e.g. dunnage sitting in ports or landfills present a high risk for a population to become established. Whereas a single pest occurrence may not be high risk as it doesn't have a mate to establish a population. Data to quantify this risk would be ideal.

4. New tools and technology – Day 4 – November 28th

Session Moderator: Thomas Schröder

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 and served on the IPPC Technical Panel on Forestry Quarantine (TPFQ) from its inception until 2016. Currently, Thomas is the deputy Chief Officer of Plant Health Services (COPHS) of Germany in the Plant Health Division of the Federal Ministry of Food and Agriculture.

4.1 Carbon accounting and forests – *Smyth*

Author: Carolyn Smyth

Presenter Bio: Carolyn Smyth, PhD, is a Research Scientist with the Canadian Forest Service and has been on the carbon accounting team for over 15 years. She leads national analyses of climate change mitigation including carbon emissions and removals in forest ecosystems, carbon in harvested wood products and substitution benefits of avoided fossil fuel burning or emissions intensive materials.

Abstract: This presentation will discuss tools and methods to estimate forest carbon emissions and removals in Canada's managed forest and tracking of carbon in wood products. Impacts of natural disturbances and future mitigation activities will be discussed to identify research priorities.

Discussion: How long following a forest fire does it take for a forest stand to remove the same amount of carbon from the atmosphere as it did before the fire? Decades.

A controversial discussion is ongoing on the framework of forests as a carbon sink. Over the stock life, the carbon sink saturates. This needs to be taken into account when forest stands are going to be placed under long-term protection without the harvest of any wood.

Sometimes following a forest fire, a new forest cannot develop. Instead, shrub land replaces the forest. This also has an effect on carbon storage.

4.2 Carbon and the Wood Packaging Industry: Finding a path forward- *Gething*

Author: Brad Gething

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 11 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.

Abstract: This presentation will lay the groundwork toward understanding the challenges and opportunities that are emerging for the wood packaging industry as the world becomes more carbon conscious. Several facets of carbon accounting will be explored, with the intended purpose of creating a dialogue within IFQRG to identify research and project priorities.

Discussion: Are individual pallet companies issuing specific environmental product declarations (EPDs) or are they using the generic industry wide one? Primarily the generic industry wide one.

Within the WPM repair and remanufacture process, in defined cases it is obligatory to retreat the wood, even when only marked (treated) WPM material is used. Are there other methods/measures available to prove that the wood complies without a retreatment? Once a specific moisture content (MC) is reached, there is no infestation possible. Individual cases should be considered. A pallet, which is several years old, will not be infested nor can be infested again. Nevertheless, under the current rules, it needs to be retreated when remanufactured.

Research Needs: Data are missing for risk over time concerning harmful organisms in WPM.

4.3 Insect and disease disturbances and their carbon impacts in forests - *Greenwood*

Author: Leigh Greenwood

Presenter Bio: Leigh Greenwood is the Forest Pest and Pathogen 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.

Abstract: Major efforts are underway to harness the carbon sequestration capacity of forests to combat global climate change. However, tree damage and death associated with insect and disease disturbance can reduce this carbon sequestration capacity. We quantified average annual changes in live tree carbon accumulation associated with all (both native and non-native) insect and disease disturbances utilizing the most recent (2001 – 2019) remeasurement data from National Forest Inventory plots in the contiguous United States. Forest plots recently impacted by insect disturbance sequestered on average 69% less carbon in live trees than plots with no recent disturbance, and plots recently impacted by disease disturbance sequestered on average 28% less carbon in live trees than plots with no recent disturbance. Nationally, we estimate that carbon sequestration by live trees, defined as the estimated average annual rate of above- and belowground carbon accumulation, has been reduced by 9.33 teragrams carbon per year in forests that have experienced recent insect disturbance and 3.49 teragrams carbon per year in forests that have experienced recent disease disturbance, for a total reduction of 12.83 teragrams carbon per year. Strengthened international trade policies and phytosanitary standards as well as improved forest management have the potential to protect forests and their natural capacity to contribute to climate change mitigation from the impacts of both native and non-native invasive forest insects and diseases.

Discussion: Concerning figure 7 of the presentation, what was the reason for the detections and what can be done to reduce the numbers? What proportion is due to fraud resulting in harmful organisms being detected in WPM?

A statement was made that there are numerous pathways for hitchhikers.

A participant indicated that there is a study from the economic perspective, on whether WPM should be treated or not. WPM treatment should also be analyzed from the carbon emission view. The discussion on the influence of carbon storage balance concerning invasive insects and diseases from plants is relatively new.

Q: To solve the climate crisis, is it sufficient just to plant trees?

A: This point of view is too simple. It is true that each tonne of carbon removed counts but replanting a clear cut cannot substitute the initial stand 1:1. For each forest damage scenario, an individual solution is necessary. A sustainable managed forest has positive effects on carbon storage. There is a need to understand the effects of a natural versus managed in the ability of a forest to store carbon.

Research Needs: Interception at import versus risk of establishment in an importing country?

4.4 Molecular methods for detecting *Agrilus* spp. using frass, larvae, and plant tissues – *Peterson*

Author: Donnie Peterson

Presenter Bio: Donnie Peterson is a Postdoc at Swedish University of Agricultural Sciences. Most of his career has been investigating various aspects of management and plant resistance of emerald ash borer (*Agrilus planipennis*). More recently, he has been exploring the use of environmental DNA to detect woodboring pests for early monitoring or detection.

Abstract: Buprestids are an emerging threat to broadleaf forests across the world. One species, bronze birch borer (*Agrilus anxius*, BBB) poses a serious threat to European birch species if the insect were to be introduced. Due to their cryptic lifestyle feeding on vascular tissue of their host plants, buprestids and other woodborers can be difficult to observe or detect. Early detection tools are vital to swiftly implement eradication measures and further prevent the establishment of introduced species. Plant chemicals may limit the performance of these assays, so we conducted sensitivity testing with extracted foliage and plant vascular tissues to determine potential inhibition effects on DNA amplification. We also conducted field validation studies on the capacity to detect BBB DNA in the field and laboratory with larvae and frass. Plant chemicals in DNA extracts from leaves did not impact the sensitivity of the LAMP or qPCR assays, reaching similar detection levels. In contrast, vascular tissue appeared to impact the ability for LAMP to

detect the DNA. These results demonstrate that both assays are highly specific and sensitive tools that can be used to detect BBB from frass and identify larvae, and as well as monitor the spread of *A. anxius*, and that qPCR is more sensitive than LAMP overall. Thus, if fine detection is critical, then qPCR is preferential. If results are needed quickly to make fast management decisions, the LAMP method is optimal.

Discussion: Can eDNA analysis be used for the designation of pest free areas? CFA would not accept that at this stage. Positive detection by eDNA analysis would provide evidence that there is an infestation somewhere. In the USA, phytosanitary measures are currently only ordered on the basis of eDNA results if the harmful organism is physically present.

It is currently not possible to prove the genus using eDNA. e.g., the genus *Agrilus* contains more than 4000 species, and it was questioned whether at least the genus can be determined as long as there are not protocols available for all species of a genus.

Q: A question was raised whether an eradication campaign is worth the cost of eradication measures versus the impact of the harmful organism.

4.5 Heat treatment of EAB prepupae– sub-lethal temperature effects at the molecular level - *Williams*

Authors: Holly Williams[1], Gwylim S. Blackburn[1]*, Esme John[1], Chris J. K. MacQuarrie[2], Meghan Noseworthy[1], Tyranna Soque[1]

1. NRCan CFS, Pacific Forestry Centre, Victoria, British Columbia, Canada
2. NRCan CFS, Great Lakes Forestry Centre, Sault Ste. Marie, Ontario, Canada

Presenter Bio: Holly Williams, MSc. has studied molecular pathology at the Pacific Forestry Centre in Victoria, BC, Canada of the Canadian Forest Service, Natural Resources Canada for over 20 years. She uses molecular techniques to study host-pathogen interactions and more recently is using molecular techniques and bioinformatics to assess gene expression in a number of systems.

Abstract: We assess, from a molecular perspective, the sub-lethal effects of heat on *Agrilus planipennis* (emerald ash borer; EAB) at different temperature-time combinations applied at or slightly below the ISPM 15 standard (56°C for 30 min; “56/30”). Sub 56/30 heat treatment doses resulted in arrested metamorphosis and ultimate death (Noseworthy *et al*. 2023). Here, we document the developmental trajectory of EAB treatment survivors compared to control individuals in terms of activity across gene pathways that are involved in development and metamorphosis. We will present the preliminary results of our analysis, including key genetic responses to different sublethal heat treatment conditions.

Discussion: The results are useful also for the definition of "treatments". A treatment does not need to be lethal in all cases as long as the organism is no longer fertile or dies before mating.

The commonly used term "heat shock protein" would be better named "stress shock protein" to make it clear that there is more than heat influencing gene expression and protein synthesis. In the current research it would have been helpful to investigate the potential to survive or die before pupation. In the "old" DH-analyses, insects which did not die before pupation were ranked as survivors.

In the framework of developing DH treatments survivors have been regularly observed.

4.6 International Standard for Phytosanitary Measures (ISPM) 15 - New Treatments - Criteria for developing treatments for wood packaging material in international trade – *Ormsby*

Author: Mike Ormsby

Presenter Bio: Dr Mike Ormsby is the Principal Adviser of the Office of the Chief Biosecurity Officer, Ministry of Primary Industries. He has for many years managed a team of scientists in the New Zealand Ministry of Primary Industries to assess pest risks to New Zealand and oversees research programs to support pest management. Dr Ormsby has worked in the phytosanitary area for over 25 years and has been a member of IFQRG and the IPPC technical panels for treatments and forest quarantine since 2005.

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 that lead treatment developers through a process that culminates in confirmatory trials on a single easily accessible wood pest.

Discussion: For treating wood blocks infested with fungi, it is recommended to use at least three different fungal strains.

Industry is often faced with the argument that 56/30 is not sufficient to kill all organisms. Initial ISPM 15 (2002) was only tested against a limited number of organisms. Nevertheless, several participants believed that failures resulting in non-compliances are due to implementation mistakes. The influence of heat on living organisms is well-known and has been widely tested.

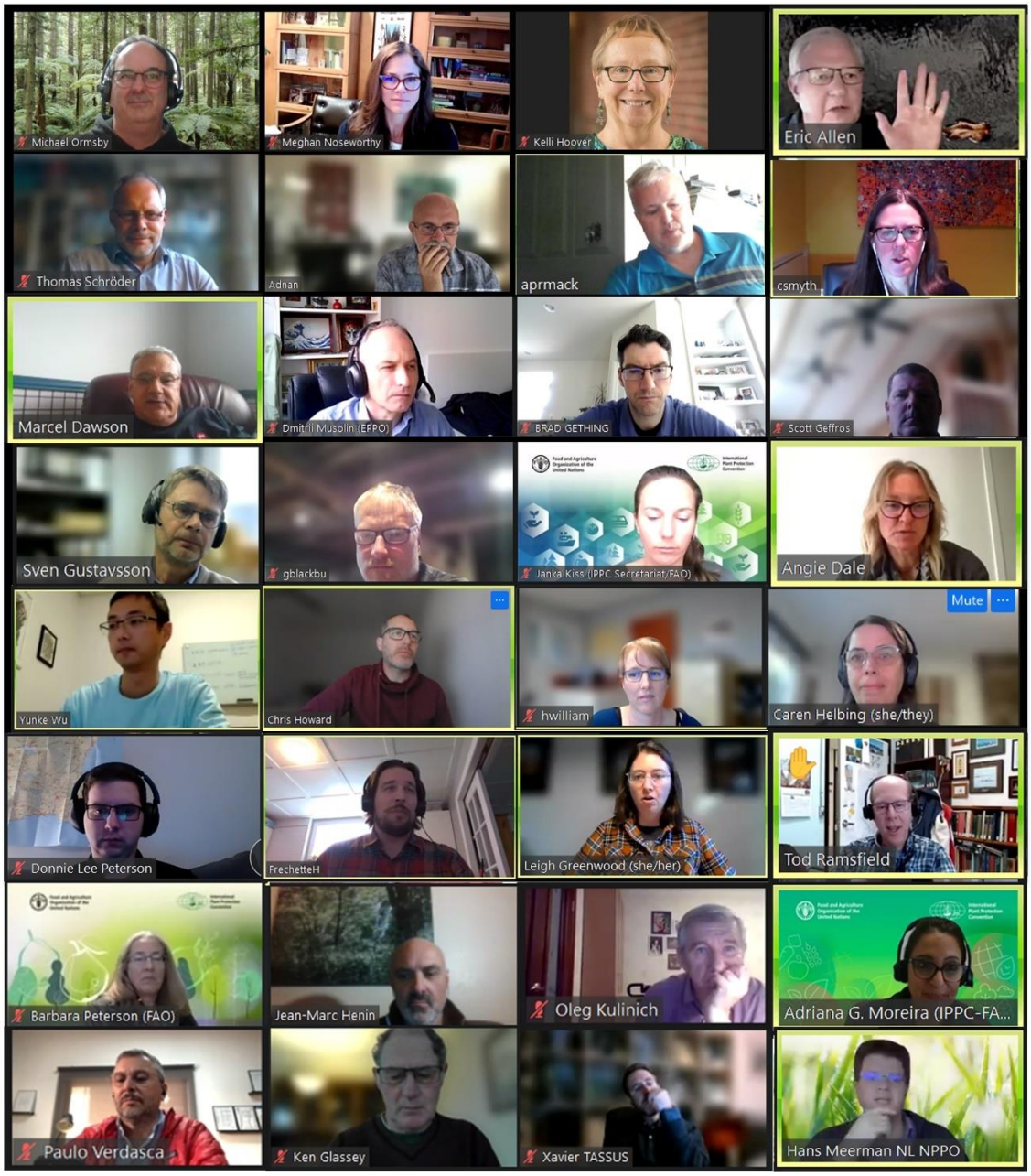
The aim of ISPM 15 is to significantly reduce infestation and is not a 100% sterilization of the WPM.

Q: A participant asked whether the old IPSM 15 (56/30) parameter would pass the requirements of the "Ormsby paper" and what would happen if not. Other participants believed that 56/30 is effective, but the temperature measurement is the weak point. Cold spots and regular calibration of the sensors is key. Also, the number of sensors in the kiln (e.g., Portugal uses 16 temperature probes in a kiln with 3000 pallets).

If new treatments are available and accepted by the TPPT and IPPC process, they would first become a treatment in ISPM 28 and following that, in ISPM 15.

Research Needs: A better understanding of Dose / Delivery (e.g., using the Humble water bath).

2023 Symposium Participants



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