

Examination of Phytosanitary Issues related to Bark on Wood Packaging Material and ISPM 15 Treatments

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The following series of questions related to phytosanitary issues of bark of ISPM 15 compliant wood packaging material were answered by the November/December, 2005 meeting of the International Forest Quarantine Research Group.

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Q1: What is wood packaging?

The following is a description of wood packaging from ISPM 15 section 2. Regulated Wood Packaging Material:

“These guidelines are for coniferous and non-coniferous raw wood packaging material that may serve as a pathway for plant pests posing a threat mainly to living trees. They cover wood packaging material such as pallets, dunnage, crating, packing blocks, drums, cases, load boards, pallet collars, and skids which can be present in almost any imported consignment, including consignments which would not normally be the target of phytosanitary inspection. Wood packaging made wholly of wood-based products such as plywood, particle board, oriented strand board or veneer that have been created using glue, heat and pressure or a combination thereof should be considered sufficiently processed to have eliminated the risk associated with the raw wood. It is unlikely to be infested by raw wood pests during its use and therefore should not be regulated for these pests.”

Q2: What pests are associated with untreated wood packaging material and to what level?

Although no all-inclusive lists exist, quarantine agencies globally have reported the detections/interceptions of numerous species of insects, many of which are known serious forest threats on untreated wood packaging. Haack (2006) has reviewed reports of the occurrence of pests on untreated wood packaging from a number of countries. In Annex 1 of ISPM 15, a number of pest groups are listed as being a concern and necessitating the requirements specified in ISPM No. 15.

ISPM 15 Annex 1: Pest groups

Insects	Anobiidae	
	Bostrichidae	
	Buprestidae	
	Cerambycidae	
	Curculionidae	
	Isoptera	
	Lyctidae	
	Oedemeridae	
	Scolytidae	
	Siricidae	
Nematodes		<i>Bursaphelenchus xylophilus</i>

This list does not represent all groups that could be associated with wood packaging. In addition, interception records from Chile (1995-1999) list the following families of beetles as being associated with wood packaging material on arrival in Chile.

From pre-ISPM 15 data (Chile) – insect families:

Anobiidae	Chrysomelidae	Histeridae	Mycetophagidae
Bostrichidae	Cicindelidae	Lathrididae	Platyodidae
Brentidae	Cleridae	Leiodidae	Ptinidae

Bruchidae	Colydiidae	Lyctidae	Scarabaeidae
Buprestidae	Cryptophagidae	Lymexylidae	Scolytidae
Cantharidae	Cucujidae	Melandrydae	Silvanidae
Carabidae	Curculionidae	Meloidae	Staphilinidae
Cerambycidae	Dermestidae	Melyridae	Tenebrionidae
			Trogoidea

It is also accepted that other pest groups, such as fungi and bacteria, can be associated with wood packaging material prior to ISPM 15 treatment.

The actual levels of pests in wood packaging before treatment varies based on time of year, country of origin, type of wood, species of wood, and type of wood packaging. Data from Allen and Humble 2002 (IFQRG 2005-31), demonstrated that ~22% of untreated wire rope spools imported to Canada from China contained live insects. However, there currently are no general audit data indicating the overall level of infestation of untreated wood packaging material in service.

Q3: What is the level of pests following ISPM 15 treatment?

The level of infestation immediately following ISPM 15 treatment is dependent on the efficacy of the treatment, the proficiency in application of the treatment and, subsequently, the rate of infestation, if any, after treatment. The recorded levels of infestation in port-of-entry audits may be influenced by the fraudulent marking of wood packaging so that the wood is in reality untreated. Bark on wood may reduce the efficacy of methyl-bromide fumigation under published protocols, but is not expected to reduce the efficacy of heat treatment. Wood moisture levels are also likely to affect the efficacy of methyl-bromide fumigation, and the likelihood of infestation following treatment. The presence of bark will increase the length of time taken for the wood to reach equilibrium moisture content (See Q. 10).

Australian audit data (IFQRG 2005-32) indicated about 0.5% of ISPM 15 marked wood packaging material was infested. The accuracy of this information is conditional on inspection proficiency, validity of marking, randomness of sampling (potential bias toward higher or lower risk WPM), and infestation after treatment. “Marked” means marked in compliance with ISPM 15. It can not be determined from audit information if “marked” or “unmarked” wood packaging material has been treated.

Q3b: What is the incidence of infestation on wood packaging material imported into countries requiring ISPM 15 compliance?

Audit information from the EU (IFQRG 2005-25) recorded after implementation of ISPM 15, indicates that around 0.3% of wood packaging material was infested. Approximately 82% of the imported wood packing material was marked in compliance with ISPM 15.

Q4: What is the evidence of infestation of treated wood with bark when compared with treated wood without bark?

Research confirms that treated wood with bark can become infested (IFQRG 2005-07, 08, 09, 10, 11, 12, 13, 14). In some research papers results indicated that heat or methyl bromide treatment may make wood more attractive to ambrosia beetles (IFQRG 2005-12).

Australian audit information (IFQRG 2005-32) indicates, but can not confirm, that under some circumstances treated wood with bark can become infested in trade. The accuracy of this information is conditional on the validity of marking and the representative nature of the sample. No information is available on the relative distribution in the sample of the various types of WPM, i.e. logs, wedging material and pallets, which are well known to pose varying risk. Furthermore, these audits can not confirm that wood packaging material marked in compliance with ISPM 15 was in fact treated in compliance with ISPM 15.

Research also indicates that wood without bark is far less susceptible to insect infestation than wood with bark on (IFQRG 2005-06, 07, 11, 14). Australian audit information (IFQRG 2005-32) indicates that wood packaging material marked in compliance with ISPM 15 and containing bark is 3 times more likely to be infested than bark-free (as per the IPPC Expert Working Group proposed definition. ISPM 15 2005-05) wood packaging material marked in compliance with ISPM 15. However, the Australian data, like the EU data (IFQRG 2005-25), do not allow a conclusion to be drawn on the significance of bark and pests associated with treated material, since it was not possible to confirm if marked material had in fact been treated.

Q5: What are the post-treatment levels of infestation (with and without bark) compared with pre-treatment levels?

Overall, from the studies presented (IFQRG 2005-07, 08, 09, 10, 11, 12, 13, 14) there is either:

- a) no significant difference between infestation levels of treated and untreated wood; or
- b) differences identified are related to the species of insect which may prefer treated or untreated wood.

Supporting information from a North American study (IFQRG 2005-27) is summarised in the Table below (Data are numbers of beetles per cm²):

Bark size	Bark beetles		All borers	
	Control	HT	Control	HT
25 cm ²	0.01	0.0035	0.0133	0.0064
100 cm ²	0.005	0.01	0.0086	0.015
100% coverage	0.0087	0.012	0.0118	0.0137

Q6: Do pests both attack and breed in wood with bark?

Research completed to date clearly shows that pests can both attack and breed in ISPM 15 treated wood with bark under favourable conditions. (IFQRG 2005-07, 08, 09, 10, 11, 12, 13, 14).

Q7: What organisms have been observed to attack (and breed) in ISPM 15-treated wood?

The following organisms were found in research experiments to infest ISPM 15-treated wood.

IFQRG 2005	Host Material	Pest type	Genus/species
12 (UK)	<i>Pinus sylvestris</i>	Insects	<i>Tomicus piniperda</i>
			<i>Hylurgops palliatus</i>
			<i>Orthotomicus laricis</i>
			<i>Hylastes ater</i>
			<i>Hylastes sp.</i>
			<i>Ips sexdentatus</i>
11 (Canada)	<i>Pinus</i>	Insects	<i>Trypodendron lineatum</i>
			<i>Ips pini</i>
			<i>Dendroctonus muraryanae</i>
			<i>Hylergops porosus</i>
			<i>Orthotomicus caelatus</i>
			<i>Pissodes sp.</i>
13,14 (Germany)	Spruce	Insects	<i>Pityogenes chalcographus</i>
10 (USA 2004)	Hickory	Insects	<i>Xylosandrus germanus</i>
			<i>Monarthrum mali</i>
	Maple	Insects	<i>Monarthrum mali</i>
			<i>Xylosandrus germanus</i>
			<i>Xyloterinus politus</i>
	Oak	Insects	<i>Monarthrum mali</i>
			<i>Xylosandrus germanus</i>
	Pine	Insects	<i>Orthotomicus caelatus</i>
			<i>Ips grandicollis</i>
			<i>Gnathotrichus materiarius</i>
6, 7, 8, 9 (USA 2005)	Pine	Insects	<i>Gnathotrichus materiarius</i>
			<i>Hylastes opacus</i>
			<i>Ips grandicollis</i>
			<i>Ips pini</i>
			<i>Orthotomicus caelatus</i>
			<i>Monochamus spp.</i>
		Nematodes	<i>Bursaphelenchus xylophilus</i>

Audit data collected in Australia (IFQRG 2005-32) and the EU (IFQRG 2005-25) detected the following organisms in ISPM 15-marked wood packaging material.

Pest type	Family	Genus/species
Insects	Bostrichidae	<i>Sinoxylon anale</i>
(Wood pests only)		<i>Dinoderus minutus</i>
		<i>Heterobostrychus aequalis</i>
	Cerambycidae	<i>Monochamus alternatus</i>
		<i>Stromatium</i> sp.
	Scolytidae	
	Buprestidae	
Fungi		<i>Aureobasidium</i> sp.
		<i>Penicillium</i> sp.
Nematodes		<i>Bursaphelenchus mucronatus</i>
		<i>Helicotylenchus</i> sp.
		<i>Aphelenchoides</i> sp.
		<i>Bursaphelenchus xylophilus</i>

Because the audit information may also include organisms found on WPM that was marked ISPM 15 compliant but not treated, the existence of pests does not prove conclusively that they could inhabit treated WPM.

Q8: When wood has been treated, what is the importance of bark piece size on infestation and breeding success rates?

The studies presented (IFQRG 2005-07, 08, 09, 10, 11, 12, 13, 14) did not establish a lower limit to the bark sizes that were capable of supporting successful attack by bark beetles. The lowest amount of bark tested was 12%, although in the Canadian study bark residues were as small as 6.45 cm² (1 inch square). The Canadian study (IFQRG 2005-11), however, is not yet complete and it is not yet possible to interpret the information in relation to bark areas colonised. Haack reported that at his lowest level of bark coverage (25 cm²) many of the beetles failed to complete their lifecycles. The consensus was that size of beetle might affect requisite size of bark patch necessary to establish and breed.

The German studies (IFQRG 2005-13, 14) can be summarised in the Table below:

		Slabs - Percentage bark cover			
	logs	100%	50%	25%	12%
Area per bark section (cm ²)	1570	400	200	100	48
Total area per piece (cm ²)	1570	800	400	400	384
Total beetles	2778	677	870	974	624
No per cm ²	0.18	0.08	0.22	0.24	0.16

This suggests that there is equal likelihood of breeding in all categories of bark size in the slab wood.

Data from a North American study (IFQRG 2005-27) are summarised in the Table below (Data are number of beetles per cm²):

Bark size	Bark beetles		All borers	
	Control	HT	Control	HT
25 cm ²	0.01	0.0035	0.0133	0.0064
100 cm ²	0.005	0.01	0.0086	0.015
100% coverage	0.0087	0.012	0.0118	0.0137

In this study, there was greater attack on the smaller bark pieces, again indicating that the minimum size for supporting successful infestation had not been reached. Results also indicate that the ability of pests to complete their lifecycle decreases with bark size, although the threshold has not been determined.

Q9: How long is treated wood (with or without bark) suitable for colonization by quarantine pests?

This question has not been directly answered by research or audit data collected to-date. Published information and research data presented to IFQRG (December 2005) (see Q8) indicates, however, that some pests of potential phytosanitary concern will find that heat or Methyl bromide treated wood will no longer be suitable for colonisation, some such pests will find that the treated material will be colonisable for a short time only, some will find that it will be colonisable for a longer period, while some will find that such material will be colonisable until destruction.

It should be noted that some pests of phytosanitary concern will complete their life cycle once they have infested wood, regardless of how the wood properties deteriorate or alter over time.

Q10: What is the importance of decreasing moisture levels? How long does wood packaging take to reach equilibrium moisture content?

As moisture content (MC) decreases, susceptibility to infestation also decreases. The rate of moisture decline and the ability of pests to infest WPM may be dependent on factors such as the season in which the wood is harvested, the type or species of wood used, the type or species of organism attempting to infest the WPM, and the storage and use of the WPM, the relative humidity, the ambient temperature and the airflow around and through the WPM. There exists a body of knowledge regarding MC reduction by air drying that can be applied to WPM as individual circumstances warrant.

Q11: In international trade, what levels of pests are found in ISPM 15-treated wood packaging with attached bark (audit results)?

Australian audit information (IFQRG 2005-32) indicates that the infestation level of wood packaging material marked in compliance with ISPM 15 and containing bark in excess of

current Australian acceptance standards (credit card size) is 2%. This compares to bark-free ISPM 15 marked wood packaging material infestation levels of 0.5%.

The Australian data provided to IFQRG did not identify WPM by origin. IFQRG suspects that further investigations might find that fledgling programs from certain countries of origin are responsible for the bulk of these interceptions. Hopefully, as programs mature monitoring will ensure more consistently effective treatments. IFQRG considers that, to gain a clearer understanding of wood packaging infestation rates, further audit data are required that are collected using unified protocols for adequate comparison. It was also noted, however, that it cannot be determined from the audit information collected to-date if “marked” or “unmarked” wood packaging material has actually been treated successfully.

Q12: How much bark (of what size) is moving with wood packaging (audit data)?

Audit data from the EU (IFQRG 2005-25) and Australia (IFQRG 2005-32), while not being directly comparable, indicated the following:

The EU reported the rate of presence of bark from 9,978 consignments:

< 1% bark:	97%*
1 – 5% bark:	2.9%
> 5% bark:	0.1%

* a large majority of these being completely bark-free

Australia reported around 8% of the wood packaging material sampled was considered to have “significant” (greater than credit card size) amounts of bark. An observation from Australia added:

“On the issue of bark, the amount found with insects also present was very variable, from thick strips on edges of pallet boards, to small or residual amounts of a centimetre or so thick and 5 to 10 centimetres long NOT associated with knots or inclusions. This was fairly typical.”

IFQRG considers that, to gain a clearer understanding of wood packaging bark-on rates of infestation for material in use, the collection of further audit data will be required, through the use of unified protocols that will allow for adequate comparison.

Q13: What impact does bark on wood have on the efficacy of treatments?

The efficacy of heat treatment is not impacted by the presence of bark, as effective temperature is measured at the core of the wood. Therefore wood exterior temperatures at the bark surface will be higher.

The efficacy of fumigation is potentially impacted by the presence of bark, as bark can reduce the ability of a fumigant to penetrate the WPM. This problem is only likely to be significant

in certain types of WPM that have complete coverage of bark on all exposed surfaces e.g. types of round wood dunnage.

Q14: What is the potential for fungal re-infestation of ISPM-15 compliant WPM with bark?

Many of the fungi of quarantine concern are associated with insects and therefore the risk of re-infestation is dependent on the ability of the host insects to re-infest the WPM. IFQRG considers that pathogenic fungi are unlikely to infest treated wood without these vectors. Direct fungal colonisation requires a high moisture content. The potential for direct fungal colonisation is therefore related to Q10 and the effect of bark on moisture content.

IFQRG considers that there would be value in undertaking research into the potential for fungal (and other microbiological) infestation of ISPM 15-treated wood, along with the research to determine the efficacy of current and proposed ISPM 15 treatments.

Q15: What types/forms of WPM are likely to have a significantly higher level of infestation pre-treatment or re-infestation post-treatment due to the presence of bark?

No study to-date has provided a statistically valid comparison of the risk associated with types of wood packaging. Experience suggests, however, that the following categories of wood packaging material pose different levels of risk:

Rank*	WPM Type	Type description
1	Round wood with bark	Logs or poles with complete or nearly complete bark
2	Rough sawn wood or crates	Rough sawn planks or crates/boxes made from rough sawn wood and having significant remaining bark on waney edges.
3	Pallets with > 4x4" wood	Pallets or boxes containing wood greater than 10 cm x 10cm (4"x4")
4	Pallets with < 4x4" wood	Pallets or boxes containing wood no greater than 10cm x 10cm (4"x4")
5	Commercial box packaging	Commercial shop-grade packaging for sale products or high-grade commodity packaging (e.g. wine barrels, whisky kegs)

* Risk ranked from highest (1) to lowest (5)

Plant pest interception information related to the types of wood packaging material (as supplied by APHIS from the 'Port Information Network' (PIN) database for 1985-2000 (Haack 2006) indicates the following levels of quarantine concern associated with wood (it should be noted that there was no ISPM 15 program in effect during this time):

	Dunnage	Crating	Pallets	Wood	Other or not recorded
% of Total	30%	39%	6%	16%	9%
Quarantine No	2528	3273	479	1316	745

What the information does not indicate is the relative levels of infestation compared to the volumes of each type of wood imported, or the impacts of the APHIS pre-clearance or inspection requirements on the likelihood of detecting a pest of quarantine concern.

When considering the different types of wood packaging material, and provided that more information related to products in use is available, a matrix such as the one below (relative ratings provided for example only) could be used to compare the relative levels of phytosanitary risk for each packaging class:

	Round wood	Rough sawn wood or crates	Pallets > 10cm (4'') wood	Pallets < 10cm (4'') wood	Consumer boxes
Bark-on	High	Medium	Medium-Low	Low	Very Low
Bark-off	Medium	Medium-Low	Low	Very Low	Negligible*

*i.e. that which need not be considered

Determinants for risk level would include the moisture content of the wood, the size of wood, wood quality and the level and type of infestation present at the production forest. These determinants will vary with age of the wood since felling but it would not be possible to assess this for wood in service.

Q16: Is there a difference in the infestation rate of the two types of bark freedom defined by the EWG (ISPM 15 2005-05)?

Based on the effect of bark size on likely infestation (Q8), there is currently no information to indicate that debarked wood (A4 piece of bark) is more or less likely to be infested than bark-free (credit card size piece of bark) wood (IFQRG 2005-11 and 27, definitions as per the IPPC Expert Working Group (IFQRG 2005-05)).

QLast: What evidence is there to support the hypothesis that the removal of bark would add to phytosanitary security on ISPM-15 marked wood packaging material?

Experiments conducted in 2004 and 2005 were designed to ensure that the treated wood used in the experiments would be exposed to pest attack. Material used in the research was freshly cut, green wood. These experiments clearly demonstrate that wood with individual pieces of bark as little as 25 cm² and treated under ISPM-15 requirements could be infested by pests that are of phytosanitary concern. Many of these same pests were not found to infest wood that had all bark removed.

Information collected by Australia indicated that 0.5% of ISPM-15 marked material inspected at the point of entry was infested by organisms of phytosanitary concern. This analysis suggested that material with 10 cm² or more bark had a higher level of infestation than material with small or no amounts of bark. The European Union and Canada have also reported similar levels of interceptions to Australia on marked wood. Due to uncertainty

about whether or not infestation occurred post treatment, the causal relationship cannot be determined between the presence of bark and infestation of ISPM-15 compliant material.

Additional research and inspection data, using harmonised approaches, would enable estimation of the likelihood of ISPM-15 marked material in use being infested by pests of phytosanitary concern. For example, additional research or inspections could investigate: the significance of presence and size of bark; the significance of moisture content; the effect of different categories of wood packaging with bark; the influence of heat treatment on the attractiveness of wood with bark; etc. on the likelihood of pest infestation.

References

IFQRG Nov 29, Dec 1, 2005: Document List

IFQRG Participants List	IFQRG 2005-01
Draft Agenda Updated Nov.18/05	IFQRG 2005-02
TPFQ 2005 report	IFQRG 2005-03
Terms of Reference 2005	IFQRG 2005-04
IPPC Debarking Draft Standard (presentation)	IFQRG 2005-05
Dwinell 2002 - Colonization of debarked wood	IFQRG 2005-06
Dwinell 2004 - Colonization of heat-treated wood	IFQRG 2005-07
Dwinell 2005 - Colonization of HT wood by PWN and insects	IFQRG 2005-08
Haack & Prentice 2005 - Colonization of HT pine	IFQRG 2005-09
Haack 2004 - Suitability of treated wood to beetle attack	IFQRG 2005-10
Humble 2005 - Infestation of ISPM 15-treated wood	IFQRG 2005-11
Jukes et al 2005 - Susceptibility of HT timber with bark	IFQRG 2005-12
Schroder 2004 - Reinfestation of spruce after HT	IFQRG 2005-13
Schroder 2005 - Infestation of spruce after HT	IFQRG 2005-14
IFQRG Bark discussion questions	IFQRG 2005-15
Proposed revision to MBr Schedule	IFQRG 2005-16
EMITECH Microwave results	IFQRG 2005-17
EMITECH Technical Report	IFQRG 2005-18
Kawakami MB alternatives (2005)	IFQRG 2005-19
SF Dwinell -Effect of Sulfuryl Flouride on the Pinewood Nematode in Pine	IFQRG 2005-20
Barak et al. 2005 - Container Fumigation of Regulated Wood Packing Material	IFQRG 2005-21
Barak et al. 2005 - MBr for Regulated Wood Packing Material	IFQRG 2005-22
Bond 2005 - Heat Treatment & Mold	IFQRG 2005-23
Uzunovic 2005 - Fungal HT test protocol proposal	IFQRG 2005-24
EU 1005 – Monitoring report on WPM 1 July – 30 September	IFQRG 2005-25
AHC - Design and feasibility analysis, hot water bath	IFQRG 2005-26
Haack 2005 – Insect colonization of logs and lumber (presentation)	IFQRG 2005-27
	IFQRG 2005-28
EU 2005 - position paper on the risk of bark on WPM	IFQRG 2005-29
TPPT 2005 report	IFQRG 2005-30
Allen and Humble 2002 – Nonindigenous species introductions: a threat to Canada's forests and forest economy	IFQRG 2005-31
Walsh 2005 – WPM survey data from Australia (Summary)	IFQRG 2005-32

Haack (2006). Canadian Journal of Forest Research (in press)