Risk Assessment: Potential of introducing Ips typographus into Ireland via the importation of pine logs

As a result of the current shortage of domestically produced spruce (*Picea*) logs the Irish timber industry is considering increasing the importation of logs from mainland Europe, mainly Germany, to meet domestic demand. As Ireland is designated as a Protected Zone (PZ) from certain widely distributed bark beetle pests present in Germany, such as *Ips typographus*, this potentially poses a risk of introducing the pest into Ireland.

Regulation 2019/2072 lists 3 special requirements for wood of conifers (Pinales) being imported into Ireland. These include (a) The wood is bark-free, or, (b) official statement that the wood originates in areas known to be free from *Ips typographus* Heer; or, (c) a mark 'Kiln-dried', 'KD' or another internationally recognised mark put on the wood or on its packaging in accordance with current commercial usage to prove that it has undergone kiln drying to below 20% moisture content, expressed as a percentage of dry matter, at time of manufacture, achieved through an appropriate time/ temperature schedule. Legally, at least one special requirement should be applied to pine logs before entry into Ireland.

The PRA unit was asked to investigate whether alternative methods of heat-treating wood than special requirement (c) outlined in implementing Regulation 2019/2072, may be sufficient to eradicate *I. typographus* from pine logs. The measures under consideration were those outlined in the IPPC guidance document ISPM 15: Regulation of wood packaging material in international trade, such as using conventional heat chamber technology to achieve a minimum temperature of 56°C for a minimum duration of 30 continuous minutes (international heat treatment code mark: HT) throughout the entire profile of the wood (including its core), with no requirement to affect or monitor moisture content of timber. One notable difference between heat treatments applied in Reg 2019/2072 and ISPM 15 is the requirement for debarking of timber prior to heat treatment in ISPM 15, this step was added in 2009 due to the observed high levels of bark beetle infestations surviving ISPM HT wood containing bark or reinfesting residual bark on HT logs post HT (Haack *et al*., 2014).

The risk assessment consisted of a qualitative risk assessment (review of the literature) to establish whether ISPM HT of imported pine logs could be considered sufficient to eliminate the risk of introducing the pest *I. typographus* into Ireland.

Ips typographus is listed as a protected zone quarantine pest in Regulation (EU) 2019/2072 (Annex III) for Ireland and the UK Originally native to Eurasia, *I. typographus* has now spread from its native range of spruce and is now widely distributed throughout the EU (Stadelmann *et al*., 2013). In the EFSA PLH Panel pest categorisation report a wide host range of tree species susceptible to attack which including: *Abies spp*., *Larix spp*., *Pinus spp*. and *Pseudotsuga menziesii* (EFSA PLH Panel, 2017). The EFSA PLH Panel (2017) report indicated that *I. typographus* could establish and spread in either of the Irish or UK designated PZ zone climates. This fact was confirmed by the discovery in 2018 of a breeding population of *I. typographus* in the UK during a routine surveillance on natural woodland in Kent (Duffy, 2018; GOV.UK, 2018). *Ips typographus* attacks both living and dead free-standing trees but appears to have a preference for freshly fallen log poles (Schroeder and Cocos, 2018). Storm events such as those that occurred in Germany in the 1990s have contributed substantially to *I. typographus* epidemics where fallen pine trees (i.e. windthrow) served as highly suitable breeding grounds for mass outbreaks during suitable weather conditions (Baier *et al*., 2007; Stadelmann *et al*., 2013). Initial tree infestation occurs when a male establishes a nuptial chamber under the tree bark, females are

attracted (generally 2-3) via pheromones and together they then begin construction of a gallery system (Wemelinger, 2004). Females typically lay up to 80 eggs per gallery in larvae tunnels constructed at right angles to the central gallery tunnel (Wermelinger, 2004). Larvae progress through their instar stages under the bark and generally finish maturation in the spring prior to their dispersal flight (Anon, 2015). Optimal dispersal flight activity is observed at temperatures between 22°C and 26°C, but swarming can commence at temperatures >16.5°C (Hinze and John, 2019). Under epidemic conditions, 90% of new infestations were found to occur within 100m of an old attack, however large numbers have been recorded flying larger distance with up to 50% of released *I. typographus* observed flying greater than 500m (Wermelinger, 2004). The wide disperse capabilities of *I. typographus* have been supported by findings of infestation more 6 km away from the closet spruce stand (Wermelinger, 2004). Flight distances are highly influenced by the temperature with distances of >100m generally observed on moderate or warm days compared to cooler days where distances travelled is generally <60m (Henze and John, 2019). Older trees (>70 years) appear to be more susceptible to attack than younger trees (Wermelinger, 2004). Trees attacked by *I. typographus* are not only killed by bark beetle feeding but also by pathogenic blue stain fungi, such as *Ophiostoma* and *Ceratocystis* species, that are introduced during infestation (Wermelinger, 2004). *Ips typographus* has been should to generally carry more pathogenic fungi than many other types of bark beetle (Wermelinger, 2004). The disperse capacity of *I. typographu*s coupled with its ability to establish in the Irish climate make it a considerable threat to Irish forestry and measures should be taken to prevent its introduction.

A EUPHRESCO project investigating the "Phytosanitary efficacy of kiln drying (PEKID)" on a range of wood pest organism established that KD was effective in controlling insect species including *I. typographus* and *I. sexdentus* (Schroder, 2010). When core temperatures of 56°C were maintained for a minimum of 30 minutes alongside a reduction in moisture to 20% complete mortality of the two tested *Ips* species was observed, in addition to the bark beetle *Pityogenes chalcographus*, and wood borers *Monochamus sartor, Tetropium castaneum, Tetropium fuscum* and *Arhopalus rusticus*. However, there is limited publicly available data on the effects of non KD wood heat treatments on the survival of *I. typographus* in log poles or timber. The study of Annila (1969) indicated that infested bark exposed to 50°C for 1 hour was sufficient to kill all instar stages of *I. typographus*, however, shorter durations of 30 min produced varying results depending on humidity levels in the incubation chamber. A review of heat treatment of wood and wood packaging conducted by the North American Plant Protection Organisation (NAPPO) in 2014 indicated that heating wood to 56°C for 30 min will kill most insect life stages. However, certain species were shown to be able to survive 56°C (air temperature) for 30 min durations, such as the wood boring species *Agrilus planipennis*. A review of the effectiveness of ISPM 15 for controlling wood boring species such as *A. planipennis* was published by Haack *et al*. (2014) which highlighted a lack of appropriate studies investigating the actual criteria for the most recent ISPM standard in tests. Heat treatment as defined under ISPM 15, requires a temperature of 56°C to be reached and sustained in the timber core for 30 min (56/30), which is a distinctly different metric than that of storing timber in an environment with an air temperature of 56°C for 30 min, which had been employed in a number of published studies. The time it would take for a log core to reach an internal temperature of 56°C throughout would imply storage for a longer period than 30 min in a heat chamber. The time taken for core temperatures of roundwood to reach 56°C has been reported to take up to 314 min even when chamber temperatures >60°C are used (NAPPO, 2014). The study conducted by Haack and Petrice (2010) tested the effect of heat-treating timber infested with *A. planipennis* in a 56°C chamber until the timber core reached 56°C, no survival of *A. planipennis* was observed. This finding was confirmed by Sobek *et al*., (2011) where complete mortality of all larval instars using an operational heat treatment chamber. Several studies covered in the Haack *et al*. (2014) review highlighted low levels *A. planipennis* surviving certain heat treatments,

but the heat treatments used in these studies fell short of the ISPM 15 criteria for maintaining a 56/30 inner core temperature. Though some studies investigating the ISPM 15 HT for fire logs have found the efficacy of the 56/30 treatment to be lacking for certain timber products such as firelogs (Goebel *et al*., 2010; Myers *et al*., 2009). This is possibly due to the fact the timber fire logs are spilt and of lesser thickness than logs (core temp measured as often ≤3.5 cm dept from log edge) which result in shorter durations in HT kilns necessary for the inner core temperature to reach 56°C. Maintaining inner core temperatures of timber logs at 56/30 has been shown to sufficiently eradicate larvae of the wood boring *Monochamus spp.* (Chen *et al*., 2018). Therefore, for wood boring species such as *A. planipennis* heat-treatment of debarked timber is likely to be sufficient to eradicate such organisms if undertaken correctly, but this has yet to be conclusively established (NAPPO, 2014). The same is likely to be true for *I. typographus*, though there is no direct evidence from the literature to support this.

The benefit of direct studies for specific species is also demonstrated in the case of the walnut twig beetle, *Pityophthorus juglandis* which together with the fungal pathogen *Geosmithia morbida* causes thousand cankers disease. Research by Mayfield *et al.* (2014) suggested a minimum outer sapwood temperature of 56°C maintained for 40 min is effective for eliminating the thousand cankers disease vector *Pityophthorus juglandis.* This would provide evidence that current EU phytosanitary measure options for heat treatment on wood of *Juglans* L. and *Pterocarya* Kunth, of 56°C for a minimum duration of 40 continuous minutes throughout the entire profile of the wood is sufficient for this particular species of bark beetle.

The literature would suggest that the term “debarked” does not generally ensure that pine logs are completely free from bark, surveys have indicated that debarking methods often leave small residual amounts of bark remaining on the surface of logs (Haack and Petrice, 2014). Failure of log importers to comply with the complete removal of round wood bark to meet the ‘bark-free’ definition as stated in ISPM 5 can mean bark remains on logs. This has been confirmed by the DAFM forestry unit which has inspected recent imports shipments. In one shipment of German logs inspected in August 2020, under small areas of bark *Tomicus minor* were identified. While these bark beetles are not regulated, there are no records of the presence of this species in Ireland. This highlights the risk that non-compliant ‘bark-free’ logs pose through introductions of non-native species, some of which may establish and become damaging. Studies on pine trees infested with *I. typographus* indicate that optimal maternal galley density is 500 per m^2 (Wermelinger, 2004). Such densities under indicate that there is a high chance of introducing the pest under the residual bark remaining on “debarked” trees arriving from infested areas. Certain species of *Ips* such a *I. grandicollis* has been shown to successfully infest the bark of pine timber after heat treatment (Haack and Petrice, 2014). This would indicate the potential for introducing the pest via residual bark of debarked heat-treated or kiln dried timber. Analysing the effectiveness of IPSM15 heat treatment protocol in the years before the debarked requirement was added. Evans (2007) stated that there is an increasing body of evidence that wood that has been treated to ISPM15 standards can harbour bark and wood-boring beetles, with a minimum size of bark piece of around 25-35 cm^2. His study which included a number of bark beetle species (*Tomicus piniperda, Hylurgops palliates, Orthotomicus laricis, Hylastes ater, Hylastes sp., Ips sexdentatus*) concluded that heat treatment of bark on freshly felled logs and cut wood does not make residual bark unsuitable for successful colonisation and emergence by a range of bark beetle species. Therfore, pine timber would ideally be sourced from areas where *I. typographus* (and other notable pests) is known not to be present to limit the chances of reinfestation of HT logs.

Conclusion

If the PZ special treatment option (b): "official statement that the wood originates in areas known to be free from *Ips typographus* Heer" cannot be implemented and timber must be sourced from regions such as Germany where the pest is known to be present, then heat treatment via KD is the most robust option. Alternatively, timber imports should follow the recommended Regulation (EU) 2019/2072 special treatment option (a) ensuring the timber is "bark free" as defined under ISPM 5, as this is much more likely to remove bark beetles than debarking. Given that bark beetles been shown to survive under small sections of residual bark remaining on "debarked" logs, solely relying on imported logs that are designated as "debarked" as a control option is insufficient. Special treatment option (a)) ensuring that log timber is are "bark-free" may serve to remove bark beetles, but would not be sufficient to control any bark borers if present in the timber. Special treatment option (c) kiln drying (KD) wood to below a moisture content of 20% is therefore the preferential heat treatment option for treating pine timber imports. Alternatively, heat-treatment (HT) as defined under ISPM 15 would appear to be a potential alternative to kiln drying for eradicating *I. typographus* in infested logs. However, as bark beetles have been shown to infest residual bark on "debarked" timber products post heat-treatment, even this option poses risks for introducing *I. typographus* into Ireland. ISPM 15 indicates that debarking can be undertaken either before or after heat treatment as it does not affect the overall efficacy of the treatment, however, there appears to be no proof in the literature to support this. Given the lack of publicly available supporting information for ISPM 15 heat treatment this option also carries a degree of risk. Data from the US would indicate that pests are still found during inspections on a range of ISPM 15 certified timber products, with infestation levels of 0.11-0.12% identified annually, even after the adoption of the 2013 version of ISPM 15 (Haack et al., 2014). Further research should be conducted to fully establish the efficacy of this procedure. This was acknowledged in a recent IPPC conference in 2019 (IPPC, 2020), where it was stated:

> "There is broad international acceptance of heat treatment protocols for reducing pest risk associated with wood products. The time/ temperature schedule of fifty-six degrees Celsius for thirty minutes (56/30) is globally recognized as a treatment for wood packaging in ISPM 15. There is a surprising lack of data that define the precise temperature schedules that result in insect mortality."

Therefore, any situation which relies on the importation of pine logs from EU regions where pest species are present, as a substitute to domestically produced logs will come with some degree of risk. This is particularly evident given the level of European ISPM 15 marked timber entering the US which has been found to contain pests. The review of Eyre *et al*. (2018) highlighted that of 26,008 inspections conducted on timber products arriving from the EU, 232 ISPM 15 certified consignments contained harmful pests and the ISPM 15 mark was of little value in determining if consignments were pest free compared to uncertified shipments. Ensuring importer compliance with the ISPM 15 or Regulation 2019/2072 control measures for all shipments will be of paramount importance in reducing the risk of introducing *I. typographus* and other pests.

The use of traps, such as Pheroprax, designed to lure bark beetles such as *I. typographus* could be employed alongside inspections to monitor imports of pine logs to add further assurance that the choice of timber treatment is sufficient to cover the risks of introducing the pest into Ireland. Such traps are known to be unreliable for controlling infestations but may serve for monitoring purposes (EFSA PLH Panel, 2017).

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