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European and Mediterranean Plant Protection Organization
Organisation Européenne et Méditerranéenne pour la Protection des Plantes PM 3/87 (1)

Phytosanitary procedures

PM 3/87 (1) Monitoring and consignment inspection of wood chips, hogwood and bark for quarantine pests

Specific scope

The aim of this Standard is to provide guidance on the inspection of consignments of imported wood chips, hogwood and bark for quarantine pests and monitoring of sites where these materials are imported. The Standard covers these commodities for all tree species. The Standard does not cover the inspection of highly processed wood materials (e.g. wood pellets), wood packaging materials, shavings or sawdust. Firewood is also not covered by this Standard, and EPPO recommends that firewood should be regulated as round wood.

Specific approval and amendment

Approved as an EPPO Standard in 2019–09.

1. Introduction

In 2015, EPPO carried out a study on wood commodities other than round wood, sawn wood and manufactured items (EPPO, 2015). The study gave an overview of the commodity categories of wood products in trade and included an assessment of the risks of different categories of wood products [see Appendix 2: Risk factors and possible phytosanitary measures for wood chips (adapted from EPPO, 2015)]. One of the conclusions was that some categories of wood, namely wood chips with bark larger than 2.5 cm in at least one dimension produced from fresh wood and hogwood (also known as hog fuel), present a high phytosanitary risk. Bark as a commodity and other categories of wood chips, i.e. chips of greater than 2.5 cm in at least one dimension without bark and wood chips of <2.5 cm in all dimensions with or without bark were judged to present a medium phytosanitary risk. In the current Standard these categories of wood chips, bark and hogwood (see Figs 1 and 2) are collectively called 'wood commodities'. These 'wood commodities' are considered to present a risk because the process of producing them cannot be relied upon to eliminate pests and once imported there is likely to be very little control over where they are stored and when and how they are used. Large volumes of wood chips are imported into the EPPO region, for example an average of approximately 14.5 million m^3 of wood chips and particles were imported into European countries annually between 2013 and 2017 (FAO, 2019). This figure does not necessarily equate to commodities covered by this Standard but represents an approximate 100-fold increase since the 1960s and a tenfold increase since the 1970s.

Hogwood is generally produced from wood waste for low value uses such as burning to produce heat or for power generation. Wood chips can also be used for low value uses including burning but can have alternative higher value uses such as producing paper pulp. Traded bark is usually packed and sold in various size packages as a mulch (or ground cover) for gardening. Layers of mulch are often placed around the base of trees, shrubs or herbaceous plants to conserve water and prevent the emergence of weeds. The quality, composition, origin and intended use of the wood have a major impact on pest risk and some of the categories are considered to have a high phytosanitary risk. These factors should therefore be taken into consideration for import controls. Given the large volumes of wood chips moving into the EPPO region and the lack of guidance on how inspections should be carried out, the EPPO Phytosanitary Inspections Panel decided to develop the current Standard.

2. Definitions and commodities concerned

2.1. Definitions

The EPPO (2015) study on wood commodities proposed definitions for some wood categories, including bark, wood chips and hogwood. Bark as defined in ISPM 5 is 'the layer of a woody trunk, branch or root outside of the cambium' and bark as a commodity was defined as 'bark separated from wood'. Wood chips are defined as 'wood with or without bark in the form of pieces with a definable particle size produced by mechanical treatment with sharp tools' and hogwood as 'wood with or without bark in the form of pieces of varying particle size and shape, produced by crushing with blunt tools such as rollers, hammers or flails'. The FAO has an alternative definition of wood chips: 'Chipped woody biomass in the form of pieces with a defined particle size produced by mechanical treatment with sharp tools such as knives. Wood chips have a sub-rectangular shape with a typical length of 5 to 50 mm and a low thickness compared to other dimensions' (FAO, 2004). The FAO definition of hog fuel (FAO, 2004) is the same as the EPPO definition for hogwood (EPPO, 2015). The European Standard EN 14961 for 'wood chips and hog fuel' follows the FAO definitions (Alakangas, 2011). Thus, the definitions for wood chips and hogwood are based on the processes used to produce these two different commodities rather than the size profile of the commodity. The distinction between wood chips and hogwood is not always recognized and in many publications it is not clear if authors are referring to wood chips or hogwood (e.g. Kopinga *et al*., 2010; Lamers *et al*., 2012).

Wood chips, hogwood and bark (see Figs 1 and 2) are distinct from wood pellets, which are formed by drying, grinding and extruding wood fibre under high pressure and temperature into pellets of a specified size (Goetzl, 2015). Wood pellets (see Fig. 3) belong to the category of processed wood material which is defined in the Glossary of phytosanitary terms (IPPC, 2018) as 'products that are a composite of wood constructed using glue, heat and pressure, or any combination thereof'. Wood pellets are not covered by this standard and can generally be considered a low risk for plant quarantine purposes (Callan *et al*., 2018).

Fig. 1 Hogwood and bark used as a mulch. Photo courtesy of Apostoloff, Wikimedia Commons.

Fig. 2 Wood chips (left) and hogwood (right) (Alakangas, 2011).

2.2. Wood types used to produce woodchips and hogwood

The size of pieces of 'wood commodities' varies depending on the type of wood and the machines used to create them. They may be produced from branches, off-cuttings (parts of a tree not used for the primary purpose), debris and other by-products of wood processing, but may also be produced from larger pieces of wood or whole trees (EPPO, 2015). Forest Research in the United Kingdom have categorized wood chips/hogwood according to their source as (i) forest chips (from trunks, whole trees, logging residues or stumps), (ii) wood residue chips from untreated wood residues, recycled wood and off-cuts, (iii) sawing residue chips from sawmill residues and (iv) short rotation coppice/short rotation forestry chips (Forest Research, 2018).

2.3. Size categories

Currently there is no global standard for wood chips which sets out size limits. However, there is a European Standard (EN 14961) that defines categories of wood chips and hog fuel (hogwood) based on size and other characteristics (Alakangas, 2011). According to that Standard, wood chips are divided into six size categories. In the smallest category, ≤3% of chips by weight can be greater than 16 mm long and all chips must be ≤31.5 mm long. In the largest size category, ≤6% of chips by weight can be greater than

Fig. 3 Wood pellets. Photo courtesy of Böhringer, Wikimedia Commons.

200 mm long and all chips must be ≤350 mm. Hog fuel (hogwood) is divided into seven size categories in the Standard. In the smallest category (P16) at least 75% of the chips by weight must have length ≥3.15 mm and ≤ 16 mm, ≤6% of chips by weight must have length >45 mm and all chips must have length <120 mm. In the largest category (P300) at least 75% of chips by weight must be ≥3.15 mm and ≤300 mm, and the maximum size of the rest of the consignment must be specified.

Few countries have published requirements for the dimensions of wood chips. For a commodity to be considered as wood chips in Malaysia and New Zealand, the chips need to be either no larger than 15 mm long and 10 mm in cross-section, or if >15 mm no larger than 3 mm in cross-section, otherwise the consignment is regulated as for sawn wood (Department of Agriculture Malaysia, 2014, New Zealand Ministry of Agriculture & Forestry, 2018).

2.4. Relevant international trade codes

Bioenergy related trade streams may fall under the international trade code for wood chips (HS 440120), which is subdivided into coniferous (HS 440121) or non-coniferous (HS 440122), or under the code for sawdust and 'waste' wood (HS 440130) (United Nations, 2018). In the EU, the equivalent codes are CN 44012100 for coniferous and CN 44012200 for non-coniferous chips. The other relevant eight-digit trade codes on an EU level include CN 44014090 for wood 'waste' and scrap, and CN 44013100 for pellets (EU 2018). There are no specific CN codes to cover bark, but it could be imported using any of the CN codes that cover wood chips or hogwood listed above, and potentially some other codes such as CN 1211 [Plants and parts of plants (including seeds and fruits), of a kind used primarily in perfumery], CN 1401 (Vegetable materials of a kind used primarily for plaiting) or CN 1404 (Vegetable products not elsewhere specified or included). This shows that 'specified wood' can be legitimately traded using a number of different tariff codes and there is also a risk that incorrect tariff codes are used intentionally or unintentionally.

2.5. Risks associated with wood chips, hogwood and bark

The pest groups considered likely to be associated with wood chips are insects, pathogenic decay fungi, canker fungi and nematodes (IPPC, 2017b). None of the bacteria or phytoplasmas in the EPPO A1 or A2 lists are thought to be spread by wood or wood products and thus they are not considered within this Standard. In addition, the risk of virus-like organisms being spread from wood chips/hogwood into the environment during storage and transport is low (Kopinga *et al*., 2010). Virus vectoring invertebrates (such as aphids, mites and nematodes) generally have a preference for feeding on softer parts of plants such as leaves, buds or inflorescences and not wood or bark (Kopinga *et al*., 2010).

The use of wood chips as a mulch, especially around trees, is likely to present the highest risk because of the opportunities it provides for pests to transfer to relevant hosts. Where wood chips/hogwood are used for pulp production or energy generation, the processing will kill the pests. However, conditions during transport, storage and handling prior to use may still influence the pest risk because they provide an opportunity for pests or pathogens to move to a suitable host before processing of the wood. In general, the smaller the chips, the lower the risk of introducing insect pests. The risks from nematodes and fungi, on the other hand, may be less affected by chipping (FAO, 2011), unless vectors are needed for their transmission from the wood commodity to living plants, and these vectors are killed by the chipping process.

It is likely that consignments of chipped wood will contain chips from a mixture of tree species, as a result of large-scale logging operations (Økland *et al*., 2012). As a consequence, consignments may include pests of more than one tree species. In addition, a consignment may include chipped wood from different areas of origin, making it difficult to assign the consignment with a high or low risk of pest occurrence based on a single origin.

During the chipping process there is usually a residue of wood material with varying sizes. This is known as 'wood residue' (IPPC, 2017b). The inclusion of 'wood residue' within consignments of 'wood commodities' will increase the risk of pests being present and may contravene import requirements.

The season when chips are imported and used will influence the associated risks. For example, insect pests from temperate parts of the northern hemisphere are likely to be in a dormant state if imported in the European winter. However, if the chips are subsequently stored until the spring without any processing or treatment, they may have insects present in an active state again. The stage of decay of wood chips will influence the balance between saprophytic and parasitic pathogens and the invertebrates present. Kopinga *et al*. (2010) noted that the risk of fungi spreading by insects can be decreased by transporting the raw processed material during the winter when insect activity is generally low.

If chipped wood is shipped in large bulks, self-heating might occur, reducing the survival of insects inside the consignment considerably (Sundheim *et al*., 2013). However, this will only apply to the chips (and pests) in the middle of the bulk, not those at the edges. Heat development is dependent on the moisture content, quality of the chips, external temperature and the size of the pile of wood chips (Sundheim *et al*., 2013), and therefore cannot be relied on to have a consistent impact on any pests and pathogens present.

2.6. Treatments and other phytosanitary measures

2.6.1. Chipping

Chipping of wood can be considered as a risk reduction measure itself, as it will eliminate many insects, but the impact will depend on the size of the end product (FAO, 2011). The process of wood chipping can be lethal to some insect pests, particularly for smaller chip sizes (IPPC, 2017a). In a study using 4350 pre-pupae of *Agrilus planipennis*, none were found to survive chipping (McCullough *et al*., 2007), but smaller insects (e.g. bark beetles) could potentially survive in wood chips. Even though no survivors appeared in this chipping experiment based on four infested tree trunks of *Fraxinus*, there may be a low survival rate that could result in large numbers of *A. planipennis* in imported large consignments (Økland *et al*., 2012). McCullough *et al*. (2007) did find some surviving *A. planipennis* in chips that had been produced from infested wood processed with a grinder with a 5 cm screen. In general, the chipper produced shorter chips than the grinder. For example, 84% by mass of the chips processed by the chipper would be fitted through a 2.5 cm sieve, whereas the proportions for the grinder ranged between 39 and 55% (McCullough *et al*., 2007). In the Netherlands, maximum chip size that commonly applies to consignments is 200 mm in any dimension (Kopinga *et al*., 2010). Fungal or nematode infections are unlikely to be eliminated by chipping, but the change in environment caused by the chipping process may reduce their viability.

Some of the EPPO commodity Standards (PM 8) include a recommendation for the size of chips. For example, the EPPO commodity Standard PM 8/8 *Salix (*EPPO, 2017b) gives recommendations for the appropriate sizes for wood chip in order to reduce phytosanitary risk. PM 8/8 *Salix* gives ‘Chipped to pieces of less than 2.5 cm in any dimension and transported outside of the corresponding flight periods’ as an option for reducing the risk of introducing *Apriona cinerea* or *Apriona germari*. Appendix 3 lists examples of recommended measures to reduce the risk of pest introduction on chipped wood from EPPO PM 8 Standards. These include heat treatment and the use of ionizing radiation. In addition to ‘treating’ wood, another option is to require that the chipped wood originates from a pest-free area for the pest of concern, for example PM 8/5 *Quercus* (EPPO, 2017a) includes a recommended requirement that *Quercus* ‘wood commodities’ should come from a pest-free area for *Oemona hirta*.

2.6.2. Kiln drying

Kiln drying may be considered as a heat-treatment if carried out at a sufficient temperature and for sufficient time, but only if lethal temperatures are achieved (IPPC, 2017b). In addition, modified atmospheres, such as low oxygen/high carbon dioxide environments can be used to kill or inactivate pests in wood chips (IPPC, 2017b).

2.6.3. Fumigation of woodchips

New Zealand plant quarantine authorities require that wood chips are fumigated with either methyl-bromide or sulfuryl-fluoride in separate units of $\leq 2\ m^3$ for more than 24 continuous hours at a minimum temperature of 10°C (New Zealand Ministry of Agriculture & Forestry, 2018). Israel has defined requirements for the fumigation of wood chips and bark (State of Israel Plant Protection & Inspection Services, 2014). The requirement for methyl-bromide fumigation of woodchips and bark is $80\ g\ m^{-3}$ at 10–20°C for 24 h or $48\ g\ m^{-3}$ at ≥21°C for 24 h for various insects. The use of methyl-bromide is severely restricted under the Montreal Protocol because of its impact on the ozone layer and the IPPC has provided guidance on how the use of methyl-bromide should be replaced (IPPC, 2017c). Leesch *et al*. (1989) studied the efficacy of treating pine chips with $4\ g\ m^{-3}$ phosphine while a consignment was in transit by ship from the United States to Sweden. Before shipping, pinewood nematode was present in 79% of chips and after shipping it was present in 6% of chips. Thus, phosphine reduced, but did not eliminate, the risk, of pinewood nematode and so it may need to be complemented by laboratory diagnostics for high risk consignments.

2.6.4. Aerobic composting

Aerobic composting will inactivate fungi if carried out for long enough at the right conditions (70°C for more than 1 h at a moisture content of >40% relative humidity) (Kopinga *et al*., 2010). In common with direct heat treatments, composting may not be effective throughout a whole lot without processes, such as regular turning of the consignment, to ensure that the whole lot receives the minimum treatment necessary.

3. Phytosanitary inspections

The ISPM 5 *Glossary of phytosanitary terms* (IPPC, 2018) defines inspection as ‘official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations’.

General information for carrying out import inspections is included in ISPM 20 *Guidelines for a phytosanitary import regulatory system* (IPPC, 2017a) and ISPM 23 *Guidelines for inspection* (IPPC, 2016). Further information on phytosanitary inspection of consignments is given in the EPPO Standard PM 3/72: *Elements common to inspection of places of production, area-wide surveillance, inspection of consignments and lot identification* (EPPO, 2008). Inspection should take place at the point of entry into the EPPO region in order to reduce the risk of introducing pests. However, if that is not possible, inspection should take place when the consignment is unloaded for the first time; this is the point at which the risk of spreading pests will increase. The point of entry of wood chips imported for power production is likely to be close to the place of destination because the value of the chips is not high enough to support overland transport.

Inspections will consist of visual examination for all stages of insects, or signs of insect activity, such as wood frass, also for cankers or for any discoloration of the wood that might be due to fungal infection. However, not all infestations will be clearly visible during inspections. Laboratory testing should therefore be part of the inspection process, at least if this is justified by the origin and composition of the 'chipped wood' with regard to specific pests.

The following factors should be taken into account in deciding whether and how intensively to inspect a consignment of wood commodities:

- Origin (pest outbreak areas and other continents with similar climate present the highest risk)
- wood type (regulated genera present the highest risk)
- time of year (risk of dispersal is lower in the winter)
- destination (transport, storage and intended use)
- compliance record (of the exporting country, exporter, importer and handling facility).

Consignments of 'wood commodities' are harvested from outdoor grown trees that may be of different species, grown at different times, are subject to different growing conditions and could be from different geographic origins. The possibility of significant variation in the wood chips across consignments means that it is important to try and inspect trees at a number of locations across the consignment. It is difficult to give specific recommendations about how to inspect consignments because the chips themselves can be very variable in size and so identifying the 'unit of inspection' is difficult. For consignments of up to 20 000 tonnes, it is recommended to inspect at least 20 locations and add one additional location for each 1000 tonnes above 20 000 up to a maximum of 100 locations. At each location, a minimum of 100 mL or a handful of woodchips should be closely inspected for signs of insect damage.

3.1. Verifying the species of trees from which the chipped wood is from

Trained and experienced inspectors may be able to distinguish, for example, conifer wood chips from broadleaf, or pine from spruce. However, the determination of wood species from chipped wood requires microscopic examination and is a specialist job which cannot be carried out in the field. For some samples it is possible to identify the tree species, but for others, only genus or family level identification is possible. The International Association of Wood Anatomists maintains a list of experts with the ability to carry out such identifications (http://www.iawa-website.org/downloads.html). This list includes a number of experts from the EPPO region. There is no international standard on how to identify tree species from wood samples, but there is a national standard for identifying the tree species of wooden archaeological items in Italy (UNI, 2004).

4. Pests of concern for the EPPO region

The taxa included in the following text are examples of major pests from the EPPO A1 and A2 lists and should not be considered as an exhaustive list of potential pests that may be present in consignments of chipped wood. In addition to known threats, the importation of 'chipped wood' may also provide a pathway for introducing unknown pests. The potential importance of previously unknown pests was demonstrated when *Agrilus planipennis* was first discovered in North America (Herms *et al*., 2014).

4.1. Insects

(a) Jewel beetles (Buprestidae):
Agrilus anxius is on the A1 list and *Agrilus planipennis* is on the A2 list.

Trees infested with *Agrilus anxius* are likely to contain at least one of the following: D-shaped holes created by emerging adults, larval galleries filled with frass at the phloem-xylem interface or serpentine swellings or ridges visible through the bark where wound periderm (callus) has grown over galleries (Anderson, 1944; Barter, 1957). Larvae of *Agrilus planipennis* create serpentine galleries that are filled with fine brownish frass. The galleries are generally 9–16 cm long, but can be up to 20–30 cm long and increase in width from beginning to end. They can be formed in the entire trunk and in any branches with a diameter of at least 2.5 cm. As adults emerge from host trees they create D-shaped exit holes with a width of 3.5–4.1 mm (CFIA, 2016).

Fig. 4 *Agrilus planipennis* exit hole (Ottawa, CA). Photo courtesy of D.A. Herms (EPPO Global Database).

Fig. 5 Galleries formed by *Agrilus anxius*. Photo courtesy of Eduard Jendek (EPPO Global Database).

Symptoms on wood commodities
D-shaped holes, or parts of the holes, may be visible on the inner or outer side of any bark that is present (Fig. 4). Galleries could be visible on wood chips, including outer sections of sapwood (Fig. 5), however the shape of the galleries could be difficult to determine for small pieces of wood. Frass within a grove or a section of the woodchip can provide evidence of infestation (Fig. 5).

(b) Bark and ambrosia beetles (Curculionidae: Scolytinae) and *Pissodes* sp. (Curculionidae: Molytinae)

The following species are from the EPPO A1 list: *Dendroctonus adjunctus*, *D. brevicomis*, *D. frontalis*, *D. ponderosae*, *D. pseudotsugae*, *D. rufipennis*, *Ips calligraphus*, *I. confusus*, *I. grandicollis*, *I. lecontei*, *I. pini*, *I. plastographus* and *Gnathotrichus sulcatus. Pseudopityophthorus minutissimus* and *P. pruinosus* are also on the EPPO A1 list and are vectors of the fungus *Ceratocystis fagacearum*. The following bark and ambrosia beetles are on the A2 list: *Euwallacea fornicatus* (polyphagous shot-hole borer), *Ips hauseri* (Hauser's engraver), *Ips subelongatus* (larch bark beetle), *Megaplatypus mutatus*, *Pityophthorus juglandis* (walnut twig beetle), *Polygraphus proximus* (four-eyed bark beetle) and *Scolytus morawitzi* (Morawitz's bark beetle).

Dendroctonus spp. females initiate the boring of a new gallery by constructing a radial entrance tunnel through the bark into the wood. Pitch tubes on newly infested trees range in colour from dark reddish-orange to cream; they consist of resin and particles of bark expelled from the egg gallery by the beetles. Orange to cream-coloured particles of bark and wood in crevices and at the base indicate that the tree has been infested and killed by beetles. The galleries formed by the adults and larvae are diagnostic. Within the gallery system, the entrance tunnel, mother or egg galleries and larval galleries can usually be distinguished. The entrance tunnel is usually short, more or less perpendicular to the tree axis and found at the base of simple galleries. This tunnel serves for the evacuation of frass and other debris which accumulates. *Dendroctonus* spp. close the entrance hole by tightly packing frass into the entrance. The galleries created by *Dendroctonus* spp. can be visible on the surface of wood or on the underside of bark (Fig. 6).

In *Ips* spp., the gallery system is situated in the phloem-cambial region and consists of a central nuptial chamber from which elongated egg galleries fork or radiate, forming a species-diagnostic pattern. In *I. calligraphus,* there are one to six elongated, longitudinal egg galleries 14–38 cm long, which radiate from a large centrally located nuptial chamber and *I. calligraphus* deeply score the xylem, especially in thin-barked trees. The pattern is similar to that of *I. pini,* but the galleries are wider and etch the wood deeper. The larval galleries commence more or less parallel to or divergent from the egg gallery, penetrating the bark or

Fig. 6 Example of galleries formed by *Dendroctonus* sp. (*D. frontalis*). Photo courtesy of T.S. Price, Georgia Forestry Commission, Bugwood.org.

wood to varying depths and progressively widening away from it. These galleries are usually full of debris. The gallery terminates in a small chamber, where pupation occurs and the adult emerges through a hole from this chamber. *I. typographus* exit holes are round and approximately 2–3 mm in diameter (FAO, 2007). In *Ips* spp., larval mines are short to very long, straight to irregular, and always visible on peeled bark. They are moderately long in *I. calligraphus*. The galleries and adult exit holes could be visible on the outer surface of wood without bark (Fig. 7) or by removing the bark from chips.

There are three species of *Pissodes* (Curculionidae) on the EPPO A1 list: *P. nemorensis*, *P. strobi* (see Figs 8 and 9) and *P. terminalis*. For *P. nemorensis*, the removal of bark will reveal pupal chip cocoons, cavities covered with long wood fibre usually found in the surface of the wood of the basal portion of the leader (EPPO/CABI, 1996). *Pissodes* spp. larvae create galleries in the outer surface of the wood. The galleries can be distinguished from bark beetle galleries because they are irregular and generally larger.

Fig. 7 Example of galleries formed by *Ips* sp. (*Ips grandicollis*). Photo courtesy of G.L. Lenhard, Louisiana State University, Bugwood.org.

The adults create exit holes 2–4 mm in diameter when they emerge from their host trees.

Fig. 8 *Pissodes strobi* adult. Photo courtesy of S. Jensen, Cornell University, Bugwood.org.

Fig. 9 *Pissodes strobi* larvae. Photo courtesy of D. Powell, USDA Forest Service (retired), Bugwood.org.

Symptoms on wood commodities

Exit holes, or parts of the holes, may be visible on the inner or outer side of any bark that is present. The shape of the galleries can be difficult to determine for small pieces of wood. Frass within a grove or a section of the woodchip can provide evidence of infestation.

(c) Longhorn beetles (Cerambycidae)

Anoplophora glabripennis (Asian longhorn beetle), *Saperda candida* (round-headed apple-tree borer), *Aromia bungii* (redneck long-horned beetle), *Apriona cinerea* (apple stem borer), *Apriona germari* (brown mulberry longhorn beetle), mulberry borer *Apriona rugicollis* (mulberry borer) and non-European *Monochamus* spp. vectors of *Bursaphelenchus xylophilus* are on the EPPO A1 list. *Anoplophora chinensis* (citrus longhorn beetle) is on the EPPO A2 list.

Symptoms on wood commodities

Symptoms of longhorn beetles (exit holes and larval tunnels) are unlikely to be obvious on most wood commodities covered by this Standard due to the relatively small size of the wood pieces, but may be present in larger wood chips or hogwood pieces. When trees infested with *A. chinensis* are cut into sections, the larval tunnels can be visible as elliptical holes (Fig. 10). Figure 11 shows an *A. chinensis* tunnel cut vertically through a stem of a tree.

Fig. 10 *Anoplophora chinensis* tunnels in a cut section of trunk, Lombardy, Italy. Photo courtesy of D. Eyre, Defra Crown Copyright (EPPO Global Database).

Fig. 11 Vertical section through a gallery of *Anoplophora chinensis*. Photo courtesy of Defra Crown Copyright (EPPO Global Database).

(d) Other insect pests

The moth *Lymantria mathura* (Lymantriidae) is on the EPPO A2 List. Eggs of this moth are laid in small masses underneath bark scales. After hatching, the larvae feed gregariously on the foliage of host trees.

Symptoms on wood commodities
Larvae and eggs could potentially be present on consignments of wood commodities.

4.2. Nematodes

Bursaphelenchus xylophilus, pinewood nematode, is on the A2 list.

If wood commodities with pinewood nematode are placed next to a host tree there is a theoretical risk of direct transfer from the chips/hogwood to the host, as demonstrated in a laboratory environment by Hopf-Biziks *et al*. (2017). The risk was found to be higher when (i) the host was injured in some way, (ii) there was direct contact with host trees and (iii) the temperature was higher (25°C as opposed to 15°C). This risk is most likely to arise for consignments of 'wood commodities' that are used as a mulch, but the actual risk in a field situation is uncertain.

Symptoms on wood commodities
Generally, no symptoms would be evident on wood commodities. However, when sampling for *B. xylophilus*, there is a better chance of finding the pest in blue stained pine (Maehara & Futai, 2005; Maehara *et al*., 2005).

4.3. Fungi

The following fungi are on the EPPO A1 List and could be relevant to wood commodities: *Atropellis pinicola*, *A. piniphila*, *Ceratocystis fagacearum* (Figs 12 and 13), *Coniferiporia weirii*, *Cronartium* spp. (*C. coleosporioides*, *C. comandrae*, *C. comptoniae* (Fig. 14), *C. fusiforme*, *C. himalayense*, *C. quercuum* (Fig. 15), *Endocronartium harknessii*, *Mycosphaerella gibsonii* and *Mycosphaerella laricis-leptolepidis*. In addition, EPPO A2 listed species could be relevant to 'wood commodities': *Cryphonectria parasitica* and *Heterobasidion irregulare*.

Fig. 12 Xylem of red oak affected by *C. fagacearum* showing diffuse stain (often there is less stain than this). Photo courtesy of J.N. Gibbs, Forestry Commission, UK.

Fig. 13 Sporulating mat on red oak killed by *C. fagacearum*. Photo courtesy of J.N. Gibbs, Forestry Commission, UK.

Fig. 14 *Cronartium comptoniae*. Photo courtesy of Ministère des forêts, Québec, Canada.

Fig. 15 Aecia of *Cronartium quercuum* on *Pinus taeda*. Photo courtesy of EPPO Global Database.

Fungi that have a broad range of hosts and form fruit bodies and spores on dead wood represent the highest risk. A study showed that wood chips used as mulch and infested with *Thyronectria austroamericana* (Thyronectria canker of honey locust), remained a source of inoculum for 143 weeks (Koski & Jacobi, 2004).

Symptoms on wood commodities

Generally, symptoms can include the discoloration and deformation of the bark and/or wood as a result of chlorosis and subsequent necrosis.

5. Lot identification

A 'Lot' is defined in ISPM 5 (IPPC, 2018). According to that definition a lot to be sampled should be a number of units of a single commodity identifiable by its homogeneity in various factors, e.g. origin, packing facility or exporter.

For chipped wood, the division into single units for sampling can be difficult and will depend on the way the consignment is shipped and unloaded. Chipped wood can be shipped as bulk cargo in container ships in large amounts which can contain different tree species. This makes separation into single units impossible and might complicate homogenous sampling. If chipped wood is shipped as bulk cargo, a whole shipload has to be seen as one unit.

If the consignment is shipped in bulk bags, units could either be single bulk bags or at least bulk bags from the same manufacturer.

6. Sampling and inspection procedures

6.1. Purpose of inspection and sampling

It is important to identify the purpose of the consignment inspection. Generally, the ability to detect low levels of infestation with a high degree of confidence level is desirable for phytosanitary inspections, but this may be difficult to achieve when sampling from large consignments of chipped wood. Due to the large volumes of wood chips in some consignments, it may be unfeasible to take a sufficiently large sample to detect a very low level of infestation of a selected pest in a consignment.

Økland *et al*. (2012) estimated that 27 million litres of wood chips would need to be inspected to detect the presence of the emerald ash borer with a probability of 0.90 in a shipload of wood chips. However, even if the sampling methods and capacity are not adequate to determine that a consignment is pest free, monitoring of the pathway and searching for a selected pest along the pathway may still be valuable to detect pests in order to gain intelligence on the risks of the pathway. The phytosanitary risks of the trade in these 'wood commodities' is difficult to verify, but inspections and sampling should provide evidence for whether or not further regulation is needed.

The purpose of inspection and sampling may also be to check compliance with the size requirements of the wood chips, and in this case subsamples from large amounts of wood chips may give a satisfactory result. Phytosanitary inspections are also an opportunity to check whether the consignment complies with other requirements, for example whether there is evidence to demonstrate that it originates from a pest-free area for a quarantine organism of concern. This might be carried out by checking the phytosanitary certificate and any movement documents. Over time, the inspection of chipped wood will provide evidence which will contribute to an understanding of the risks of importation and, if necessary, the evidence to support further regulation.

6.2. Sampling for laboratory testing

For detection of pest infestations, visual examination is not always sufficient and laboratory testing is necessary. Molecular methods are used for the detection of specific organisms. High-throughput sequencing (HTS) technologies allowing targeting of multiple organisms are under development but are currently not available for testing woodchips.

If there are any signs of pest infestation, if the consignment is from a new source or if the criteria in the bullet points in section 3 suggest it is high risk, a sample should be taken for laboratory analysis for quarantine pests. Due to the inconsistent risks connected with chipped wood (e.g. variation in geographical source, chip size and wood species) defining appropriate sample sizes for chipped wood is likely to be is difficult. However, sampling from various places in the consignment will enhance the likelihood of detection of pests. It is recommended that subsamples for laboratory testing of about 100 mL (or a handful) are taken from at least 20 locations in the consignment for consignments of up to 20 000 tonnes, plus one additional location for each 1000 tonnes above 20 000 tonnes. These should be taken from different locations in the consignment up to a maximum of 100 locations. The figure of 20 has been chosen in order to balance the need for a representative sample with the time constraints that inspectors are likely to experience. Samples should be taken in such a way that the risk of dissemination of pests, e.g. insects, is not enhanced. Where possible, subsamples should be taken to ensure that if there are apparent differences in the tree species composition, age or state of decomposition of the wood chips, a subsample of all the apparent species, maturities and state of decomposition of chips is included. In France, minimum sample sizes of wood chips for detecting *Bursaphelenchus xylophilus* are 100–150 g, for *Phytophthora* are 500 mL and for *Ceratocystis platani* are 200 mL.

6.3. Inspection with detection dogs

Trained detection dogs have been used successfully in Europe to identify trees and wood infested with *Anoplophora glabripennis* since 2009 (Hoyer-Tomiczek *et al*., 2016). Detection dogs have been used for detecting *Anoplophora* in consignments of imported plants, in mature trees outdoors and also in wood packaging material (Hoyer-Tomiczek & Sauseng, 2013). The use of detection dogs for finding quarantine pests in consignments of chipped wood could be considered.

Some of the challenges of using detection dogs for chipped wood are as follows: (i) the processes of chipping wood, loading it and unloading it, may spread scents widely across the chips so the point source may be difficult to localize, (ii) dogs could detect dead insects which may not be considered to be of phytosanitary concern and (iii) the great variety of potential pests that could be present in chipped wood.

There has been experimental work on the detection of volatile organic compounds using technological means rather than animals, but as yet this has not been widely adopted. Examples are the use of gas chromatography/mass spectrometry (GC-MS), electronic nose (e-nose), laser-based spectroscopy and proton transfer reaction mass spectrometry (PTR-MS) (Augustin *et al*., 2012).

6.4. Traps

Pheromone/attractant traps can be an effective means of detecting xylophagous beetles. Non-native beetles in the families Cerambycidae (longhorn beetles), Curculionidae (especially bark beetles, Scolytinae) and Buprestidae (jewel beetles) are a significant threat to forests and it is possible to catch many of the pest species from these families in traps (Brockerhoff *et al*., 2006). Beetles caught in traps could originate from locations other than the chipped wood or they could have moved onto it from another consignment or the surrounding environment. Thus, catches of non-native pests in traps will not provide proof that a particular consignment has quarantine pests, but will provide an indication that the pathway is not safe and needs to be investigated further. However, the absence of quarantine pests in traps will provide some assurance that the pathway is relatively safe.

6.4.1. Types of traps

Multi-funnel traps and cross-vane traps (Figs 16, 17) can be used for trapping xylophagous beetles (Rassati *et al*., 2014). However, multi-funnel traps are preferable for practical reasons, being quicker and easier to set up and more durable in adverse weather conditions (e.g. strong winds). One of the advantages that multi-funnel traps and cross-vane-traps with a collecting jar have over various types of sticky traps such as Delta traps is that there is a clean sample for identification

Table 1. Potential lures that could be used for attracting quarantine pests from consignments of chipped wood

Target	Possible lure	Reference	Notes
A generic trap for Cerambycidae, Scolytinae and Buprestidae	Multi-lure blend composed of α-pinene (released at 2 g day^{-1}), ipsenol (0.4 mg day^{-1}), ipsdienol 0.4 mg day^{-1}), 2-methyl-3-buten-2-ol (11 mg day^{-1}) and ethanol (0.3 mg day^{-1})	Rassati *et al*. (2015)	Multi-funnel traps were preferred
Scolytinae and Cerambycidae	Spruce blend [a blend of racemic α-pinene, (–) β-pinene, (+)-3-carene, (+)-limonene and α-terpinolene] and ethanol plus the longhorn beetle pheromones, *E*-fuscumol or *E*-fuscumol acetate	(Sweeney *et al*., 2014, 2016)	Black panel traps were used
Monochamus sp. (Cerambycidae)	(1) Ethanol, α-pinene, ipsenol, ipsdienol, methylbutanol or (2) ipsenol, 2-methyl-3-butenol-2-ol, 2-undecyloxy-1-ethanol	Halbig (2013)	Multiple-funnel traps were considered to be more suitable than cross-vane traps for windy locations
Anoplophora glabripennis (Cerambycidae)	Plant volatiles linalool, linalool oxide, *cis*-3-hexen-1-ol, *trans*-pinocarveol, δ-3-carene and *trans*-caryophyllene; with or without ♂-produced pheromone, which is a mixture of 4-(*n*-heptyloxy) butan-1-ol and 4-(*n*-heptyloxy) butanal	Nehme *et al*. (2014); Meng *et al*. (2014)	Meng *et al*. (2014) found that the height of the traps and the diameter at breast-height of the trees were not significant predictors of the number of beetles caught
Agrilus planipennis (Buprestidae)	α-cubebene, α-copaene, 7-*epi*-sequithujene, *E*-β-caryophyllene, α-humulene (also known as α-caryophyllene) and eremophilene. Six of these compounds, but not 7-epi-sequithujene, are found in Manuka oil, which is commercially available. The leaf volatile (3*Z*)-hexenol is also attractive to *A. planipennis*	Ryall (2015)	Purple and green canopy prism traps (Figs 18, 19) are widely used. Double-decker traps may provide a higher detection rate when there is a low population density. Traps baited with Manuka oil and (3*Z*)-hexenol have been used for a trapping programme in the USA and traps with just (3*Z*)-hexenol have been used in Canada
Bark beetles (Curculionidae, Scolytinae)	α-pinene plus ethanol	Brockerhoff *et al*. (2006)	Thought to be appropriate for sampling in conifers
Ips typographus (Curculionidae, Scolytinae)	Ipsdienol and s-*cis*-verbenol; s-*cis*-verbenol only	Galko *et al*. (2016)	Six trap types were tested New designs of cross-vane traps (K-trap) and a funnel trap (P-trap) were found to be most effective

(Ryall, 2015). Some of the lures used to monitor invasive xylophagous beetles are listed in Table 1.

6.4.2. Efficacy of traps

The efficiency of traps depends on the trap design and the attractiveness of the lures used. If an NPPO is particularly concerned about one high risk pest (e.g. *Agrilus planipennis*), single-lure traps could be used to monitor for these pests. In situations where there is more than one pest species of concern multi-lure traps can be used to monitor for a range of potential pests, leading to reduced material and labour costs (Hanks *et al*., 2012; Rassati *et al*., 2014).

6.4.3. Positioning of traps

Suitable minimum distances between traps will be influenced by the type of lure being used, the location of the trap and the intended target. Even with an effective pheromone, the attraction radius around each pheromone trap may be relatively small (Schlyter, 1992). Thus, insects may go undetected by pheromone traps, implying that a monitoring system of emigration from storage sites to forests may require a high trapping intensity (Skarpaas & Økland, 2009).

Pheromone traps should be set up from spring until late summer or autumn and may vary between locations due to climatic differences [see Rassati *et al*. (2015),; Catry *et al*. (2017) and Akinci & Aksu (2018), for examples). For guidance, Rassati *et al*. (2015) used pheromone traps to sample for 150 days between early May and late September around ports in Italy, Catry *et al*. (2017) sampled from late April until mid-November to study ambrosia beetles and other xylophagous insect activity in a Portuguese cork-oak forest following a fire, and Akinci & Aksu (2018) sampled from late April until late September in order to study the local spread of *Ips typographus* in Northeast Turkey.

Fig. 17 Multi-funnel traps. Photos courtesy of K.E. Gibson, USDA Forest Service, Bugwood.org.

Fig. 16 Cross vane trap set up for monitoring *Anoplophora glabripennis*, Kent, UK. Photo courtesy of D. Eyre, Defra Crown Copyright (EPPO Global Database).

Fig. 18 Green prism trap used for monitoring *Agrilus planipennis*, Toronto. Photo courtesy of D. Eyre, Defra Crown Copyright (EPPO Global Database).

Fig. 19 Purple prism trap for monitoring *Agrilus planipennis*. Photo courtesy of M.C. Whitmore, Cornell University.

6.4.4. Traps for fungal spores

Spore trapping has the potential to be used for sampling of fungi at ports, but this technology has not been widely adopted yet. In a review of the use of spore trapping for plant biosecurity, Jackson & Bayliss (2011) stated that before spore traps could become routinely used for plant biosecurity purposes, improved designs, novel applications and standard operating procedures would need to be developed.

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Appendix 1 – Short procedure for inspectors

Equipment required for sampling: sample bags, hand lens, sample tubes or bottles, knife to remove bark from chips, tape measure/ruler.

The inspection of chipped wood is likely to involve some risks to human health and safety. Inspectors should follow any relevant national health and safety guidance and regulations. Care must also be taken to minimize the risk of contaminating samples with pests from other locations, for example by wearing disposable gloves.

The following factors should be taken into account in deciding whether and how intensively to inspect a consignment of wood commodities:

- origin (pest outbreak areas and other continents with similar climate present the highest risk)
- wood type (regulated genera present the highest risk)
- time of year (risk of dispersal is lower in the winter)
- destination (transport, storage and intended use)
- compliance record (of the exporting country, exporter, importer and handling facility).

Inspectors should check the movement documents and phytosanitary certificates (PCs) relating to each consignment. These should provide information concerning the origin of the chipped wood and the species of trees it is from. If the wood is from a country where quarantine pests have been recorded on the species of wood, PCs may include information on any treatments that have been carried out, such as irradiation, fumigation or heat treatment. The information on the PC should be verified during document checks.

If a maximum size of the chipped wood is specified as part of the phytosanitary import requirement, this should be verified as part of the import inspection. If the consignment is required to be bark free, inspections should include a check for the presence of bark on any chips.

Visually inspect as much of the wood chip or bark as possible in the time available. Try to detect areas of the consignments in which the material has a different appearance. The different appearance could relate to the age of the chips, the method used to produce it or different tree species. Look out for any live or dead invertebrates in amongst the consignment and take samples. Search for any wood chips that appear to have symptoms of insect damage, such as tunnelling or fungi. Depending on the methods that have been used to transport the consignments, it may be possible to check for live insects within ships, containers or bulk bags etc. that have been used to transport the wood commodities. For consignments of up to 20 000 tonnes, it is recommended that inspection is carried out at at least 20 locations, adding one additional location for each 1000 tonnes above 20 000 up to a maximum of 100 locations. At each location, a minimum of ten chips should be closely inspected for signs of insect damage.

If there are any signs of pest infestation, the consignment is from a new source or the criteria above suggest it is high risk, a sample should be taken for laboratory analysis for quarantine pests. It is recommended that subsamples for laboratory testing of about 100 mL or a handful are taken from at least 20 locations in the consignment, for consignments of up to 20 000 tonnes, plus one additional location for each 1000 tonnes above 20 000 tonnes around the consignment up to a maximum of 100 locations.

If there is the possibility of sending a sample to a laboratory to verify the wood species (see Section 3.1) a sample of at least 2 kg should be collected by taking subsamples from each location inspected. If the consignment appears to contain a range of species of wood, an attempt should be made to sample the different species. To aid the identification of wood species, larger wood chips should be collected and especially those with a cross-section visible.

If trapping is used to improve the possibility of detecting priority pests, the traps should be set up at the import site from spring until autumn. They will need to be checked regularly to avoid the degradation of any invertebrates caught. The priority areas to survey will be areas where chipped wood is stored in the open air. Commercially available pheromone traps should be provided with recommendations on how to set them up, the recommended distance between traps, plus recommendations for how frequently the pheromone lures need to be changed.

Appendix 2 – Risk factors and possible phytosanitary measures for wood chips (adapted from EPPO 2015)

Category	Size	Customs names/ codes	Initial material	Common intended use	Pests associated	Phytosanitary measures	Knowledge gaps	Pest risk
Wood chips with bark from fresh (with intracellular moisture content suitable for pest development) and untreated wood	Larger than 2.5 cm	440121: Coniferous wood in chips or particles 440122: Non-coniferous wood in chips or particles	Round wood with bark, harvesting residues, off-cuts with bark	For fuel, production of mulch, pulp and processed wood material, for animal bedding, road covering, packing material, biofiltration	Fungi, nematodes, some bark beetles, some longhorn beetles, jewel beetles Some beetles can be attracted and transported with chips Contaminating foliage could harbour other pests	Pest free area, HT (heat treatment), DH (dielectric heating), fumigation, irradiation	Non-vector transmission of pathogens Importance of bark beetle species carried by chips	High risk
	Not larger than 2.5 cm						Non-vector transmission of pathogens Importance of bark beetle species carried by chips Survival of insects in small chips	Medium risk
Wood chips without bark from fresh (with intracellular moisture content suitable for pest development) and untreated wood	Larger than 2.5 cm		Round wood without bark, harvesting residues, off-cuts without bark				Non-vector transmission of pathogens Importance of bark beetle species carried by chips	Medium risk
	Not larger than 2.5 cm						Non-vector transmission of pathogens Importance of bark beetle species carried by chips Survival of insects in small chips	Medium to low risk (further research needed before this is regarded as low risk)
Wood chips from post-consumer and/or treated wood	NA		Post-consumer and/or treated wood	For fuel, production of mulch and processed wood material, road covering, packing material	Dry wood insects	No measures needed	Use of this kind of chips	Low risk

(continued)

Appendix 2 *(continued)*

Category	Size	Customs names/ codes	Initial material	Common intended use	Pests associated	Phytosanitary measures	Knowledge gaps	Pest risk
Hogwood (hog fuel)	NA	440121: Coniferous wood in chips or particles 440122: Non-coniferous wood in chips or particles	Round wood with or without bark, harvesting residues, off-cuts	For fuel, production of mulch and processed wood material, for animal bedding, road covering, packing material	Fungi, nematodes, bark beetles, some longhorn beetles, jewel beetles Some beetles can be attracted and transported with hogwood Contaminating foliage could harbour other pests	Pest-free area, HT, DH, fumigation, irradiation	NA	High risk unless it is produced from bark-free wood Medium risk if produced from bark-free wood Low risk if produced from post-consumer scrap wood
Bark	NA	440110: fuel wood in logs, in billets, in twigs, in faggots or in similar forms (bark is also imported using other CN codes such as waste wood, CN 44014090)	Round wood	Production of mulch, fuel, as part of growing medium, for decoration, biofiltration			Non-vector transmission of pathogens Importance of bark beetle species carried in bark	Medium risk

Appendix 3 – Examples of the recommended measures listed in EPPO commodity Standards for the importation of chipped wood

Please note that for the table below when 'OR' or 'AND'is written in capitals this separates two sections of options. When 'or' or 'and' is not in capitals this separates only one option from another

Standard	Commodity	Recommended measures
PM 8/8 (1) *Salix* (EPPO 2017b)	Processing wood residues, wood chips and hogwood of *Salix* originating in countries where *Lycorma delicatula* is present	Chipped to pieces of less than 2.5 cm in any dimension or Bark freedom or Heat-treatment according to EPPO Standard PM 10/6 or Treated with ionizing radiation according to EPPO Standard PM 10/8 AND Transported outside of the flight period or Not transported through the pest infested areas or Transported closed, to prevent infestation
PM 8/8 (1) *Salix* (EPPO 2017b)	Harvesting wood residues, processing wood residues, wood chips and hogwood of *Salix* originating in countries where *Apriona cinerea* or *Apriona germari* is present	Pest-free area for *Apriona cinerea* and *Apriona germari* or Heat-treatment according to EPPO Standard PM 10/6 or Chipped to pieces of less than 2.5 cm in any dimension AND Transported outside of *Apriona cinerea* and *Apriona germari* flight periods or Not transported through areas infested with *Apriona cinerea* and *Apriona germari* or Transported closed, to prevent infestation
PM 8/8 (1) *Salix* (EPPO 2017b)	Bark of *Salix* originating in countries where *Lycorma delicatula* is present	Free from *Lycorma delicatula*
PM 8/8 (1) *Salix* (EPPO 2017a)	Bark of *Salix* originating in countries where *Lycorma delicatula* is present	Chipped to pieces of less than 2.5 cm in any dimension or Heat treatment according to EPPO Standard PM 10/6 or Treated with ionizing radiation according to EPPO Standard PM 10/8 AND Transported outside of the flight period or Not transported through the pest infested areas or Transported closed, to prevent infestation

(continued)

Appendix 3 *(continued)*

Standard	Commodity	Recommended measures
PM 8/5 (1) *Quercus* (EPPO 2017a)	Harvesting wood residues, processing wood residues, wood chips and hogwood of *Quercus* originating in countries where *Oemona hirta* occurs	Pest-free area for *Oemona hirta* or Heat treated according to EPPO Standard PM 10/6 or Chipped to pieces of less than 2.5 cm in any dimension or to 1.5 cm in two dimensions or Appropriate fumigation, details to be specified on the PC or Harvested and imported outside of *Oemona hirta* flying period (in winter) specified in the import permit and processed before the next *Oemona hirta* flying period (only in the framework of a bilateral agreement) AND Transported outside of *Oemona hirta* flight periods or Not transported through areas infested with *Oemona hirta* or Transported closed, to prevent infestation
PM 8/5 (1) *Quercus* (EPPO 2017a)	Harvesting wood residues, processing wood residues, wood chips and hogwood of *Quercus* originating in countries where *Ceratocystis fagacearum* occurs	Pest-free area for *Ceratocystis fagacearum* OR Produced from debarked treated wood AND Produced from heat treated wood or Appropriate fumigation, details to be specified on the PC AND Transported outside of *Arrhenodes minutus*, *Pseudopityophthorus minutissimus* and *Pseudopityophthorus pruinosus* flight periods or Not transported through areas infested with *Arrhenodes minutus, Pseudopityophthorus minutissimus* and *Pseudopityophthorus pruinosus* or Transported closed, to prevent infestation
PM 8/5 (1) *Quercus* (EPPO 2017a)	Harvesting wood residues, processing wood residues, wood chips and hogwood of *Quercus* originating in countries where *Cryphonectria parasitica* occurs	Pest-free area for *Cryphonectria parasitica* OR Produced from wood which was debarked AND Heat treated
PM 8/5 (1) *Quercus* (EPPO 2017a)	Bark of *Quercus* originating in countries where any of the following pests occur: *Ceratocystis fagacearum*, *Cronartium fusiforme*, *Cronartium quercuum*, *Cryphonectria parasitica*	Free from the relevant pests listed in the middle column
PM 8/5 (1) *Quercus* (EPPO 2017a)	Bark of *Quercus* originating in countries where *Ceratocystis fagacearum* occurs	Pest-free area for *Ceratocystis fagacearum* or Appropriate fumigation, details to be specified on the PC or Heat treatment

(continued)

Appendix 3 *(continued)*

Standard	Commodity	Recommended measures
PM 8/5 (1) *Quercus* (EPPO 2017a)	Bark of *Quercus* originating in countries where *Cronartium fusiforme*, *Cronartium quercuum or Cryphonectria parasitica* occur	Pest-free area for *Cronartium fusiforme*, *Cronartium quercuum* and *Cryphonectria parasitica* or Appropriate fumigation, details to be specified on the PC or Heat treatment
PM 8/2 (3) Coniferae (EPPO 2018)	Particle wood (wood chips, hogwood), harvesting and processing residues of Coniferae (except *Thuja* and *Taxus*) originating in countries where *Bursaphelenchus xylophilus* is present	Heat-treated to achieve a minimum temperature of 56°C for a minimum duration of 30 continuous minutes throughout the entire profile of each piece of the wood OR Pest-free area for *Bursaphelenchus xylophilus* AND Transported outside of the *Monochamus* flight period or Not transported through areas infested with *Bursaphelenchus xylophilus* or Transported closed, to prevent infestation
PM 8/2 (3) Coniferae (EPPO 2018)	Isolated bark of *Larix* originating in countries where *Dryocoetes confusus*, *Gnathotrichus sulcatus*, *Ips hauseri*, *Ips subelongatus*, *Malacosoma disstria*, *Polygraphus proximus*, *Scolytus morawitzi*, *Tetropium gracilicorne* or *Xylotrechus altaicus* is present	Heat-treated to achieve a minimum temperature of 56°C for a minimum duration of 30 continuous minutes throughout the entire profile of each piece of the bark OR Pest-free area for the relevant pests listed in the middle column AND Transported outside of the flight period of the relevant pests listed in the middle column or Not transported through areas infested with the relevant pests listed in the middle column or Transported closed, to prevent infestation
PM 8/2 (3) Coniferae (EPPO 2018)	Harvesting wood residues, processing wood residues, wood chips and hogwood of *Pinus* originating in countries where *Dendroctonus adjunctus*, *Dendroctonus brevicomis, Dendroctonus frontalis, Dendroctonus ponderosae*, *Ips calligraphus*, *Ips confusus*, *Ips grandicollis*, *Ips lecontei*, *Ips paraconfusus*, *Ips pini*, *Ips plastographus*, *Ips hauseri*, *Ips subelongatus*, *Pissodes nemorensis*, *Pissodes strobi*, *Pissodes terminalis* or *Polygraphus proximus* is present	Produced from debarked wood or Heat-treated to achieve a minimum temperature of 56°C for a minimum duration of 30 continuous minutes throughout the entire profile of each piece of the wood OR Pest-free area for the relevant pests listed in the middle column AND Transported outside of the flight period of the relevant pests listed in the middle column or Not transported through areas infested with the relevant pests listed in the middle column or Transported closed, to prevent infestation