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Pest categorisation of non-EU *Monochamus* spp.

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Abstract

The Panel on Plant Health performed a pest categorisation of non-EU *Monochamus* spp., a well-defined insect genus in the family Cerambycidae (Insecta: Coleoptera). Species can be identified using taxonomic keys at national and regional level, and DNA barcoding. Two online world catalogues exist for the genus. The genus includes about one hundred species and many subspecies colonising conifers and non-conifer trees in many areas in the world. The non-EU species are listed in Annex IAI of Council Directive 2000/29/EC. Although *Monochamus* spp. colonise weakened or dead trees and have therefore no direct impact, some species vector the pine wood nematode, *Bursaphelenchus xylophilus,* which they inoculate to healthy trees when they proceed to maturation feeding on twigs, causing high mortality among pines in Asia and the EU (Portugal). Sixteen species in Asia and America attack conifers. The main pathways for entry are raw untreated wood and wood products, wood packaging material, particle wood and waste wood, finished wood products and hitchhiking. *Monochamus* species were categorised in two groups. The first group includes 16 species colonising conifers and absent in the EU known or likely to vector the pine wood nematode. The species in this group satisfy all the criteria to be considered as Union quarantine pests. Measures are in place to prevent the introduction of *Monochamus* with coniferous wood. The second group gathers all the remaining species, all non-EU species colonising non-conifers. These do not satisfy all the criteria to be considered as Union quarantine pests. As plants for planting are not a pathway for *Monochamus* spp., and as most of the species within these groups are absent from the EU territory, the two groups do not meet the criteria to be considered as regulated non-quarantine pests.

Keywords: European Union, pest risk, plant health, quarantine, sawyer beetles, pine wood nematode, *Bursaphelenchus xylophilus*

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Amendment: An editorial correction was carried out that does not materially affect the contents or outcome of this scientific output. Finland was removed from the distribution table in Appendix B. To avoid confusion, the older version has been removed from the EFSA Journal, but is available on request, as is a version showing all the changes made.

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

1.1.1. Background

Council Directive 2000/29/EC[1] on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community establishes the present European Union plant health regime. The Directive lays down the phytosanitary provisions and the control checks to be carried out at the place of origin on plants and plant products destined for the Union or to be moved within the Union. In the Directive's 2000/29/EC annexes, the list of harmful organisms (pests) whose introduction into or spread within the Union is prohibited, is detailed together with specific requirements for import or internal movement.

Following the evaluation of the plant health regime, the new basic plant health law, Regulation (EU) 2016/2031[2] on protective measures against pests of plants, was adopted on 26 October 2016 and will apply from 14 December 2019 onwards, repealing Directive 2000/29/EC. In line with the principles of the above mentioned legislation and the follow-up work of the secondary legislation for the listing of EU regulated pests, EFSA is requested to provide pest categorizations of the harmful organisms included in the annexes of Directive 2000/29/EC, in the cases where recent pest risk assessment/pest categorisation is not available.

1.1.2. Terms of Reference

EFSA is requested, pursuant to Article 22(5.b) and Article 29(1) of Regulation (EC) No 178/2002[3], to provide scientific opinion in the field of plant health.

EFSA is requested to prepare and deliver a pest categorisation (step 1 analysis) for each of the regulated pests included in the appendices of the annex to this mandate. The methodology and template of pest categorisation have already been developed in past mandates for the organisms listed in Annex II Part A Section II of Directive 2000/29/EC. The same methodology and outcome is expected for this work as well.

The list of the harmful organisms included in the annex to this mandate comprises 133 harmful organisms or groups. A pest categorisation is expected for these 133 pests or groups and the delivery of the work would be stepwise at regular intervals through the year as detailed below. First priority covers the harmful organisms included in Appendix 1, comprising pests from Annex II Part A Section I and Annex II Part B of Directive 2000/29/EC. The delivery of all pest categorisations for the pests included in Appendix 1 is June 2018. The second priority is the pests included in Appendix 2, comprising the group of *Cicadellidae* (non-EU) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), the group of *Tephritidae* (non-EU), the group of potato viruses and virus-like organisms, the group of viruses and virus-like organisms of *Cydonia* Mill., *Fragaria* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Ribes* L., *Rubus* L. and *Vitis* L. and the group of *Margarodes* (non-EU species). The delivery of all pest categorisations for the pests included in Appendix 2 is end 2019. The pests included in Appendix 3 cover pests of Annex I part A section I and all pests categorisations should be delivered by end 2020.

For the above mentioned groups, each covering a large number of pests, the pest categorisation will be performed for the group and not the individual harmful organisms listed under "such as" notation in the Annexes of the Directive 2000/29/EC. The criteria to be taken particularly under consideration for these cases, is the analysis of host pest combination, investigation of pathways, the damages occurring and the relevant impact.

Finally, as indicated in the text above, all references to 'non-European' should be avoided and replaced by 'non-EU' and refer to all territories with exception of the Union territories as defined in Article 1 point 3 of Regulation (EU) 2016/2031.

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[1] Council Directive 2000/29/EC of 8 May 2000 on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community. OJ L 169/1, 10.7.2000, p. 1–112.

[2] Regulation (EU) 2016/2031 of the European Parliament of the Council of 26 October 2016 on protective measures against pests of plants. OJ L 317, 23.11.2016, p. 4–104.

[3] Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. OJ L 31/1, 1.2.2002, p. 1–24.

1.1.2.1. Terms of Reference: Appendix 1

List of harmful organisms for which pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

Annex IIAI

(a) Insects, mites and nematodes, at all stages of their development

Aleurocantus spp.
Anthonomus bisignifer (Schenkling)
Anthonomus signatus (Say)
Aschistonyx eppoi Inouye
Carposina niponensis Walsingham
Enarmonia packardi (Zeller)
Enarmonia prunivora Walsh
Grapholita inopinata Heinrich
Hishomonus phycitis
Leucaspis japonica Ckll.
Listronotus bonariensis (Kuschel)
Numonia pyrivorella (Matsumura)
Oligonychus perditus Pritchard and Baker
Pissodes spp. (non-EU)
Scirtothrips aurantii Faure
Scirtothrips citri (Moultex)
Scolytidae spp. (non-EU)
Scrobipalpopsis solanivora Povolny
Tachypterellus quadrigibbus Say
Toxoptera citricida Kirk.
Unaspis citri Comstock

(b) Bacteria

Citrus variegated chlorosis
Erwinia stewartii (Smith) Dye
Xanthomonas campestris pv. *oryzae* (Ishiyama) Dye and pv. *oryzicola* (Fang. et al.) Dye

(c) Fungi

Alternaria alternata (Fr.) Keissler (non-EU pathogenic isolates)
Anisogramma anomala (Peck) E. Müller
Apiosporina morbosa (Schwein.) v. Arx
Ceratocystis virescens (Davidson) Moreau
Cercoseptoria pini-densiflorae (Hori and Nambu) Deighton
Cercospora angolensis Carv. and Mendes
Elsinoe spp. Bitanc. and Jenk. Mendes
Fusarium oxysporum f. sp. *albedinis* (Kilian and Maire) Gordon
Guignardia piricola (Nosa) Yamamoto
Puccinia pittieriana Hennings
Stegophora ulmea (Schweinitz: Fries) Sydow & Sydow
Venturia nashicola Tanaka and Yamamoto

(d) Virus and virus-like organisms

Beet curly top virus (non-EU isolates)
Black raspberry latent virus
Blight and blight-like
Cadang-Cadang viroid
Citrus tristeza virus (non-EU isolates)
Leprosis
Little cherry pathogen (non-EU isolates)
Naturally spreading psorosis
Palm lethal yellowing mycoplasm
Satsuma dwarf virus
Tatter leaf virus
Witches' broom (MLO)

Annex IIB

(a) Insect mites and nematodes, at all stages of their development

Anthonomus grandis (Boh.)
Cephalcia lariciphila (Klug)
Dendroctonus micans Kugelan
Gilphinia hercyniae (Hartig)
Gonipterus scutellatus Gyll.
Ips amitinus Eichhof
Ips cembrae Heer
Ips duplicatus Sahlberg
Ips sexdentatus Börner
Ips typographus Heer
Sternochetus mangiferae Fabricius

(b) Bacteria

Curtobacterium flaccumfaciens pv. flaccumfaciens (Hedges) Collins and Jones

(c) Fungi

Glomerella gossypii Edgerton
Gremmeniella abietina (Lag.) Morelet
Hypoxylon mammatum (Wahl.) J. Miller

1.1.2.2. Terms of Reference: Appendix 2

List of harmful organisms for which pest categorisation is requested per group. The list below follows the categorisation included in the annexes of Directive 2000/29/EC.

Annex IAI

(a) Insects, mites and nematodes, at all stages of their development

Group of Cicadellidae (non-EU) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), such as:

1) *Carneocephala fulgida* Nottingham
2) *Draeculacephala minerva* Ball
3) *Graphocephala atropunctata* (Signoret)

Group of Tephritidae (non-EU) such as:

1) *Anastrepha fraterculus* (Wiedemann)
2) *Anastrepha ludens* (Loew)
3) *Anastrepha obliqua* Macquart
4) *Anastrepha suspensa* (Loew)
5) *Dacus ciliatus* Loew
6) *Dacus curcurbitae* Coquillet
7) *Dacus dorsalis* Hendel
8) *Dacus tryoni* (Froggatt)
9) *Dacus tsuneonis* Miyake
10) *Dacus zonatus* Saund.
11) *Epochra canadensis* (Loew)
12) *Pardalaspis cyanescens* Bezzi
13) *Pardalaspis quinaria* Bezzi
14) *Pterandrus rosa* (Karsch)
15) *Rhacochlaena japonica* Ito
16) *Rhagoletis completa* Cresson
17) *Rhagoletis fausta* (Osten-Sacken)
18) *Rhagoletis indifferens* Curran
19) *Rhagoletis mendax* Curran
20) *Rhagoletis pomonella* Walsh
21) *Rhagoletis suavis* (Loew)

(c) Viruses and virus-like organisms

Group of potato viruses and virus-like organisms such as:

1) Andean potato latent virus
2) Andean potato mottle virus
3) Arracacha virus B, oca strain
4) Potato black ringspot virus
5) Potato virus T
6) non-EU isolates of potato viruses A, M, S, V, X and Y (including Yo, Yn and Yc) and Potato leafroll virus

Group of viruses and virus-like organisms of Cydonia Mill., Fragaria L., Malus Mill., Prunus L., Pyrus L., Ribes L.,Rubus L. and Vitis L., such as:

1) Blueberry leaf mottle virus
2) Cherry rasp leaf virus (American)
3) Peach mosaic virus (American)
4) Peach phony rickettsia
5) Peach rosette mosaic virus
6) Peach rosette mycoplasm
7) Peach X-disease mycoplasm
8) Peach yellows mycoplasm
9) Plum line pattern virus (American)
10) Raspberry leaf curl virus (American)
11) Strawberry witches' broom mycoplasma
12) Non-EU viruses and virus-like organisms of *Cydonia Mill., Fragaria L., Malus Mill., Prunus L., Pyrus L., Ribes L., Rubus L.* and *Vitis L.*

Annex IIAI

(a) Insects, mites and nematodes, at all stages of their development

Group of *Margarodes* (non-EU species) such as:

1) *Margarodes vitis* (Phillipi)
2) *Margarodes vredendalensis* de Klerk
3) *Margarodes prieskaensis* Jakubski

1.1.2.3. Terms of Reference: Appendix 3

List of harmful organisms for which pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

Annex IAI

(a) Insects, mites and nematodes, at all stages of their development

Acleris spp. (non-EU)
Amauromyza maculosa (Malloch)
Anomala orientalis Waterhouse
Arrhenodes minutus Drury
Choristoneura spp. (non-EU)
Conotrachelus nenuphar (Herbst)
Dendrolimus sibiricus Tschetverikov
Diabrotica barberi Smith and Lawrence
Diabrotica undecimpunctata howardi Barber
Diabrotica undecimpunctata undecimpunctata Mannerheim
Diabrotica virgifera zeae Krysan & Smith
Diaphorina citri Kuway
Heliothis zea (Boddie)
Hirschmanniella spp., other than *Hirschmanniella gracilis* (de Man) Luc and Goodey
Liriomyza sativae Blanchard
Longidorus diadecturus Eveleigh and Allen
Monochamus spp. (non-EU)
Myndus crudus Van Duzee
Nacobbus aberrans (Thorne) Thorne and Allen
Naupactus leucoloma Boheman
Premnotrypes spp. (non-EU)
Pseudopityophthorus minutissimus (Zimmermann)
Pseudopityophthorus pruinosus (Eichhoff)
Scaphoideus luteolus (Van Duzee)
Spodoptera eridania (Cramer)
Spodoptera frugiperda (Smith)
Spodoptera litura (Fabricus)
Thrips palmi Karny
Xiphinema americanum Cobb sensu lato (non-EU populations)
Xiphinema californicum Lamberti and Bleve-Zacheo

(b) Fungi

Ceratocystis fagacearum (Bretz) Hunt
Chrysomyxa arctostaphyli Dietel
Cronartium spp. (non-EU)
Endocronartium spp. (non-EU)
Guignardia laricina (Saw.) Yamamoto and Ito
Gymnosporangium spp. (non-EU)
Inonotus weirii (Murril) Kotlaba and Pouzar
Melampsora farlowii (Arthur) Davis
Mycosphaerella larici-leptolepis Ito et al.
Mycosphaerella populorum G. E. Thompson
Phoma andina Turkensteen
Phyllosticta solitaria Ell. and Ev.
Septoria lycopersici Speg. var. *malagutii* Ciccarone and Boerema
Thecaphora solani Barrus
Trechispora brinkmannii (Bresad.) Rogers

(c) Viruses and virus-like organisms

Tobacco ringspot virus
Tomato ringspot virus
Bean golden mosaic virus
Cowpea mild mottle virus
Lettuce infectious yellows virus
Pepper mild tigré virus
Squash leaf curl virus
Euphorbia mosaic virus
Florida tomato virus

(d) Parasitic plants

Arceuthobium spp. (non-EU)

Annex IAII

(a) Insects, mites and nematodes, at all stages of their development

Meloidogyne fallax Karssen
Rhizoecus hibisci Kawai and Takagi
Popillia japonica Newman

(b) Bacteria

Clavibacter michiganensis (Smith) Davis et al. ssp. *sepedonicus* (Spieckermann and Kotthoff) Davis et al.
Ralstonia solanacearum (Smith) Yabuuchi et al.

(c) Fungi

Melampsora medusae Thümen
Synchytrium endobioticum (Schilbersky) Percival

Annex IB

(a) Insects, mites and nematodes, at all stages of their development

Leptinotarsa decemlineata Say
Liriomyza bryoniae (Kaltenbach)

(b) Viruses and virus-like organisms

Beet necrotic yellow vein virus

1.2. Interpretation of the Terms of Reference

In Council Directive 2000/29/EC, *Monochamus* spp. are listed as *Monochamus* spp. (non-European). In this opinion, we focus on *Monochamus* spp. not present in EU countries.

Monochamus spp. (non EU species) are listed in the Appendices to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether they fulfil the criteria of quarantine pests or those of regulated non-quarantine pests for the area of the EU excluding Ceuta, Melilla and the outermost regions of Member States (MS) referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores.

Monochamus spp. do not qualify as pests by themselves, as they attack weakened or dead trees (Akbulut and Stamps, 2012; Akbulut et al., 2017; Ethington, 2015; Hellrigl, 1970). However, 13 species in the genus (*M. alternatus, M. carolinensis, M. galloprovincialis, M. marmorator, M. mutator, M. nitens, M. notatus, M. obtusus, M. saltuarius, M. scutellatus, M. sutor, M. titillator* and *M. urussovii*) can vector the pine wood nematode (PWN), *Bursaphelenchus xylophilus*, responsible for the pine wilt disease (PWD) in North America, Asia and Europe (Akbulut and Stamps, 2012; Akbulut et al., 2017), which is present in Portugal and transient in Spain (EPPO, 2018). The fact that *Monochamus* species native to Asia (*M. alternatus*) and to Europe (*M. galloprovincialis*) are able to vector the North American PWN suggests that all *Monochamus* species using PWN host plants are potential vectors for the PWN (Akbulut and Stamps 2012; Akbulut et al., 2017). This opinion will thus focus on the *Monochamus* species (listed in Appendix B) attacking pines and, more generally, conifers. It should be noted that five of these species (*M. galloprovincialis, M. urussovii, M. saltuarius, M. sutor* and *M. sartor*) do occur in the EU, but are also present in third countries where the pine wood nematode is present. However, the introduction of PWN-infected *Monochamus* species should be limited by the import requirements as specified in Council Directive 2000/29/EC. Non-EU *Monochamus* species are considered in this opinion because they could become new vectors of the PWN within the EU territory.

It should be noted that *Monochamus* species are also associated with the transmission of fungal tree pathogens including Dutch elm disease, chestnut blight, dieback of balsam fir, oak wilt and hypoxylon canker (Donley, 1959; Linsley, 1961; Nord and Night, 1972; Ostry and Anderson, 1995; Alisson et al., 2004). It is uncertain how important *Monochamus* spp. are as vectors of these fungal pathogens.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *Monochamus* spp. was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database, using the scientific name of the genus as search term. Relevant papers were reviewed and further references and information were obtained from experts, as well as from citations within the references and grey literature.

2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from the European and Mediterranean Plan Protection Organization (EPPO) Global Database (EPPO, 2018) and relevant publications.

Data about the import of commodity types that could potentially provide a pathway for the pest to enter the EU and about the area of hosts grown in the EU were obtained from EUROSTAT (Statistical Office of the European Communities).

The Europhyt database was consulted for pest-specific notifications on interceptions and outbreaks. Europhyt is a web-based network run by the Directorate General for Health and Food Safety (DG SANTÉ) of the European Commission, and is a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. The Europhyt database manages notifications of interceptions of plants or plant products that do not comply with EU legislation, as well as notifications of plant pests detected in the territory of the Member States (MS) and the phytosanitary measures taken to eradicate or avoid their spread.

2.2. Methodologies

The Panel performed the pest categorisation for *Monochamus* spp., following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018) and in the International Standard for Phytosanitary Measures No 11 (FAO, 2013) and No 21 (FAO, 2004).

This work was initiated following an evaluation of the EU plant health regime. Therefore, to facilitate the decision-making process, in the conclusions of the pest categorisation, the Panel addresses explicitly each criterion for a Union quarantine pest and for a Union regulated non-quarantine pest in accordance with Regulation (EU) 2016/2031 on protective measures against pests of plants, and includes additional information required in accordance with the specific terms of reference received by the European Commission. In addition, for each conclusion, the Panel provides a short description of its associated uncertainty.

Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. All relevant criteria have to be met for the pest to potentially qualify either as a quarantine pest or as a regulated non-quarantine pest. If one of the criteria is not met, the pest will not qualify. A pest that does not qualify as a quarantine pest may still qualify as a regulated non-quarantine pest that needs to be addressed in the opinion. For the pests regulated in the protected zones only, the scope of the categorisation is the territory of the protected zone; thus, the criteria refer to the protected zone instead of the EU territory.

It should be noted that the Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, the Panel will present a summary of the observed pest impacts. Economic impacts are expressed in terms of yield and quality losses and not in monetary terms, whereas addressing social impacts is outside the remit of the Panel.

Table 1: Pest categorisation criteria under evaluation, as defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Identity of the pest (Section 3.1)	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?
Absence/ presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest widely distributed within the EU? Describe the pest distribution briefly!	Is the pest present in the EU territory? If not, it cannot be a protected zone quarantine organism	Is the pest present in the EU territory? If not, it cannot be a regulated non-quarantine pest. (A regulated non-quarantine pest must be present in the risk assessment area)
Regulatory status (Section 3.3)	If the pest is present in the EU but not widely distributed in the risk assessment area, it should be under official control or expected to be under official control in the near future	The protected zone system aligns with the pest free area system under the International Plant Protection Convention (IPPC) The pest satisfies the IPPC definition of a quarantine pest that is not present in the risk assessment area (i.e. protected zone)	Is the pest regulated as a quarantine pest? If currently regulated as a quarantine pest, are there grounds to consider its status could be revoked?
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in, and spread within, the EU territory? If yes, briefly list the pathways!	Is the pest able to enter into, become established in, and spread within, the protected zone areas? Is entry by natural spread from EU areas where the pest is present possible?	Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects? Clearly state if plants for planting is the main pathway!
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?	Would the pests' introduction have an economic or environmental impact on the protected zone areas?	Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?
Available measures (Section 3.6)	Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?	Are there measures available to prevent the entry into, establishment within or spread of the pest within the protected zone areas such that the risk becomes mitigated? Is it possible to eradicate the pest in a restricted area within 24 months (or a period longer than 24 months where the biology of the organism so justifies) after the presence of the pest was confirmed in the protected zone?	Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria assessed by EFSA above for consideration as potential protected zone quarantine pest were met, and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential regulated non-quarantine pest were met, and (2) if not, which one(s) were not met

The Panel will not indicate in its conclusions of the pest categorisation whether to continue the risk assessment process, but following the agreed two-step approach, will continue only if requested by the risk managers. However, during the categorisation process, experts may identify key elements and knowledge gaps that could contribute significant uncertainty to a future assessment of risk. It would be useful to identify and highlight such gaps so that potential future requests can specifically target the major elements of uncertainty, perhaps suggesting specific scenarios to examine.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?

Yes, the identity of the species of the genus *Monochamus* is generally well established. The different species can be identified using taxonomic keys at national and regional level, and DNA barcoding. However, no taxonomic key at the world level is currently available.

Monochamus Dejean is an insect genus in the family Cerambycidae, subfamily Lamiinae (Arthropoda: Coleoptera). Presently, two online catalogues provide global information worldwide: Titan (http://titan.gbif.fr/), managed by G. Tavakilian and H. Chevillotte at the Museum National d'Histoire Naturelle (MNHN) and the Institut de recherche pour le développement (IRD), Paris, and the Photographic Catalogue of the Cerambycidae of the World (New World: https://apps2.cdfa.ca.gov/publicApps/plant/bycidDB/wdefault.asp?w=n; Old World: https://apps2.cdfa.ca.gov/publicApps/plant/bycidDB/wresults.asp?w=o), hosted by the California Department of Food and Agriculture (CDFA), managed by Larry G. Bezark and referred to hereunder as Bezark (2018a,b) respectively. Appendix A provides a synthetic view of these databases.

The European *Monochamus* species are listed in the *Fauna Europaea* (https://fauna-eu.org/online-databases).

There are some discrepancies regarding the total number of species/subspecies of the genus. Cesari et al. (2005), citing Hellrigl (1970), report 163 species worldwide, Tavakilian and Chevillotte (2018) report 94 species and 16 subspecies, and Bezark (2018a,b) reports 102 species and 76 subspecies. The taxonomic level of various taxa (species *vs.* subspecies) also varies according to the different sources (Appendix A).

Several confusing taxonomic conflicts must be mentioned. One of the five species that occur also in the EU, listed as *M. rosenmuelleri* in *Fauna Europaea* is recorded as *M. urussovii* by Tavakilian and Chevillotte (2018) and as *M. sutor rosenmuelleri* by Bezark (2018b). There is a claim (e.g. Wu et al., 2017) that *M. urussovii* (Fisher-Waldheim, 1806) should be *M. urussovi* (Fisher von Waldheim), and the literature is split between these two names (e.g. Bezark (2018b) and Tavakilian and Chevillotte (2018) use 'urussovii', the EPPO Global Database uses 'urussovi'). *M. carolinensis*, described by Akbulut and Stamps (2012) as the most important vector of PWN in the USA and generally accepted as a valid species (e.g. McNamara and Bousquet, 1991; Monné and Giesbert, 1995; Bezark, 2018a), is listed as *M. dentator* by Tavakilian and Chevillotte (2018) (Appendix A).

A series of national or regional taxonomic keys are available, e.g. Bense (1995), Danilevsky (2003), Harde (1966), Linsley and Chemsak (1984), McNamara and Bousquet (1991), Monné and Giesbert

(1995), Muylaert (1990), Picard (1929), Sama (2002), Wallin et al. (2013). Cesari et al. (2005) provide an analysis of the taxonomy and phylogeny of the five European *Monochamus* species, using molecular and karyological data. DNA barcoding has also been used to identify *Monochamus* larvae (Hodgetts et al., 2016; Wu et al., 2017).

Considering the large number of species in the genus *Monochamus*, as well as the limited information available for most of them, we consider hereunder two groups of species: those attacking conifers, which are either known or likely vectors of the PWN, and those attacking only non-conifer hosts. We shall also remain at the species level, not considering the largely unresolved issue of subspecies.

Tavakilian and Chevillotte (2018) and Bezark (2018a,b) list nine non-European species attacking conifers in Asia, and seven species in North America: *M. alternatus*; *M. basifossulatus*; *M. carolinensis*; *M. clamator*; *M. dentator*; (= *M. carolinensis*); *M. grandis*; *M. guerryi*; *M. impluviatus*; *M. marmorator*; *M. nitens*; *M. notatus*; *M. obtusus*; *M. scutellatus*; *M. subfasciatus*; *M. talianus*; *M. titillator*. In addition to these, the five European species, *M. galloprovincialis*, *M. saltuarius*, *M. sartor*; *M. sutor, M. urussovii,* also attack conifers.

The host plants and geographic distribution of these 21 species are listed in Appendix B.

3.1.2. Biology of the pest

Monochamus spp. feed on conifers and/or broad-leaved trees, attacking weakened, dying or freshly cut trees and are viewed as secondary pests (Akbulut et al., 2017). The species attacking conifers colonise trees of the genera *Pinus* L., *Picea* Mill., *Abies* Mill., *Cedrus* Trew, *Juniperus* L., *Cryptomeria* D. Don., *Tsuga* Carrière, and *Pseudotsuga* Carrière.

The biology of *Monochamus* spp. is summarised in a series of reviews. Hellrigl (1970) describes the biology of the European species (*M. sartor, M. urussovii, M. sutor, M. galloprovincialis* and *M. saltuarius*). Akbulut and Stamps (2012) review the biology of 13 species worldwide: *M. carolinensis* (=*M. dentator*)*, M. scutellatus*; *M. titillator*; *M. mutator*, *M. obtusus, M. notatus*, *M. marmorator*, *M. alternatus*, *M. nitens*, *M. saltuarius*, *M. urussovii*, *M. sutor* and *M. galloprovincialis*. This section mainly summarises these reviews.

The eggs are laid singly or in little groups in a slit or a pit made by the female's mandibles in the bark of weakened or recently dead trees. According to species, they are laid in various parts of the trees, including smaller branches down to 2 cm in diameter. Thin bark is preferred by some species, such as *M. alternatus* (Kobayashi et al., 1984). Fecundity varies between and within species. For example, tested on logs, *M. galloprovincialis* was found to lay an average of 67 eggs in *Pinus pinaster* in Portugal (Naves et al., 2006), 126 eggs in *Pinus sylvestris* and 57 eggs in *Pinus nigra* in Turkey (Akbulut, 2009) and 138 eggs in *P. sylvestris* in France (Koutroumpa et al., 2008). The early larval instars develop entirely under the bark. Late instars construct galleries in the sapwood where they bore oval shaped galleries. Cannibalism has been observed to exert a high impact on the larvae. For example, it reduced the immature survival of *M. carolinensis* to 6–15% in the laboratory (Akbulut et al., 2004). Pupation occurs at the end of the larval gallery, in a chamber plugged with wood shavings, close to the surface. Metamorphosis occurs in the pupal niche, in which the young adults still spend a few days before emerging through a round hole in the bark. After emergence, the adults need to feed on the living bark of young twigs for sexual maturation. This phase is obligatory before oviposition. There is a wide between- and within-species variation in adult longevity, from ca. 1 month to ca. 5 months. Within any *Monochamus* species, specific host preferences are observed. For example, *M. alternatus* attacks 18 *Pinus* species, 3 *Picea* species and 1 species of *Abies*, *Cedrus* and *Larix* (Kobayashi, 1988).

Depending on the species and also on the geographic location, the time of the year when oviposition occurs, the host species and the possible occurrence of larval diapause, *Monochamus* spp. can be multivoltine (several generations per year), univoltine or semivoltine (life cycle in more than 1 year) (Akbulut et al., 2017). In Portugal and in France, respectively, 5% and 8.1% of a sample of *M. galloprovincialis* completed their life cycle in 2 years, whilst the bulk of the insects took only one year (Koutroumpa et al., 2008; Naves et al., 2008).

Thirteen species are known so far to vector the PWN (Akbulut and Stamps 2012; Akbulut et al., 2017; EPPO GB 2018; CABI CPC 2018; see Table 2). The nematodes develop through four juvenile stages before reaching the adult stage. In wood infested with *Monochamus* spp., nematode populations build up through the propagative lifecycle, but during pupation of the beetle the nematodes change their life strategy by entering the dispersal life cycle. In close proximity with the pupal chamber, a special juvenile stage of the nematode (the third dispersal stage) accumulates in the adjacent wood. During pupation of the beetle this juvenile stage moults to the fourth dispersal stage (the dauerlarva) which invade the pupal chamber, and after the eclosion of the beetle, the dauerlarvae enter the tracheal system (Mamiya, 1984). The dauerlarvae leave the beetle to enter the feeding scars made by the beetle on the twigs of healthy trees or when females oviposit in the bark of weakened or dead host.

The most important and effective vectors of the PWN are *M. carolinensis* in the USA, *M. alternatus* in Eastern Asia, and *M. galloprovincialis* in Europe (Akbulut et al., 2017).

3.1.3. Intraspecific diversity

Tavakilian and Chevillotte (2018) report 94 species and 16 subspecies, and Bezark (2018a,b) reports 102 species and 76 subspecies. The taxonomic level of various taxa (species vs. subspecies) also varies according to the different sources (Appendix A). Tavakilian and Chevillotte (2018) list nine non-European species and five subspecies attacking conifers in Asia, and seven species and six subspecies in North America. Bezark (2018a,b) reports nine species and 14 subspecies in Asia, and six species and 19 subspecies in North America (Appendix A).

The study of the intraspecific diversity within the genus *Monochamus* is still largely in progress. For example, a recent work by Haran et al. (2017) using polymorphic microsatellites and samples from 45 European locations has shown that five distinct populations of *M. galloprovincialis* exist in Europe. On the other hand, this study did not find any support to validate the distinction between two subspecies made so far in Europe (e.g. *Fauna Europaea* 2018), *M. galloprovincialis galloprovincialis* and *M. galloprovincialis pistor.*

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, the pest can be identified visually as immatures in attacked trees, or as adults on the trunks. It can also be efficiently trapped using a pheromone, '*monochamol*' (2-undecyloxy-1-ethanol) combined with kairomones (host plant volatiles and bark-beetle pheromones).

Taxonomic keys are available and barcoding techniques have been developed (see Section 3.1.1).

The trees that attract and harbour *Monochamus* spp. are weakened, dying or dead, and their needles are therefore often partly or completely discoloured. Close scrutiny may allow the detection of oviposition slits in the bark of dead or dying trees, oval-shaped larval entrance holes in the sapwood under the dead bark, or round adult exit holes in the sapwood. Larvae can also be excavated from the bark or sapwood, and adults can be found walking or resting on cut or dead wood during the growing season.

However, the most efficient detection method is trapping. *Monochamus* spp. produce a male aggregation pheromone, *monochamol* (2-undecyloxy-1-ethanol), which has been identified from *M. galloprovincialis* (Pajares et al., 2010), *M. alternatus* (Teale et al., 2011) and *M. scutellatus* (Fierke et al., 2012). Bark-beetle pheromones were also shown to attract significant numbers of *M. clamator*, *M. obtusus*, *M. notatus*, and *M. scutellatus* to baited traps (Allison et al., 2001). In Europe, Álvarez et al. (2016) identified the best combination of attractants among a range of possibilities: *monochamol* plus two bark beetle pheromones: ipsenol and methyl-butenol. This blend, plus α-pinene, deployed with black Teflon-coated cross-vane traps in the USA, Canada and China, proved efficient as well towards non-European *Monochamus* species: *M. carolinensis*, *M. mutator*, *M. notatus*, *M. s. scutellatus*; *M. obtusus*, *M. clamator*, *M. titillator* in North America; and *M. alternatus* in China (Boone et al., 2018).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

Monochamus species are widespread throughout the whole world (Appendix A). Thirteen species are known so far to vector the PWN (Table 2). Five species are present in the EU (*M. galloprovincialis, M. urussovii, M. saltuarius, M. sutor* and *M. sartor*), but have a wide distribution also in Asia.

Table 2: Distribution of *Monochamus* spp. which are known to be vectors of the pine wood nematode (EPPO, 2018; CABI, 2018, accessed on 6.4.2018; Akbulut and Stamps, 2012; Akbulut et al., 2017; Wallin et al., 2013). The first four species from the left are also (but not only) present in the EU

			Species present in the EU				Species absent in the EU								
Continent	**Country**	**State/region**	***M. galloprovincialis***	***M. urussovii***	***M. saltuarius***	***M. sutor***	***M. alternatus***	***M. carolinensis***	***M. marmorator***	***M. mutator***	***M. nitens***	***M. notatus***	***M. obtusus***	***M. scutellatus***	***M. titillator***
Africa	Algeria		x												
	Morocco		x												
	Tunisia		x												
America	Canada	Alberta								x		x		x	
		British Columbia										x	x	x	
		Manitoba							x			x		x	
		New Brunswick						x	x	x		x		x	
		Newfoundland												x	
		Northwest Territories								x		x		x	
		Nova Scotia							x			x		x	
		Ontario						x	x	x		x		x	x
		Prince Edward Island										x		x	
		Quebec						x	x	x		x		x	
		Saskatchewan								x		x		x	
		Yukon Territory												x	
	Mexico													x	
	USA	Alabama						x						x	x
		Alaska												x	
		Arkansas						x						x	x
		California											x	x	
		Connecticut							x					x	x
		Delaware							x					x	x
		Florida						x						x	x
		Georgia						x							x
		Idaho											x		
		Illinois						x	x					x	x
		Indiana						x	x					x	x
		Iowa						x							x
		Kansas						x							
		Kentucky						x						x	x
		Louisiana						x						x	x
		Maine						x	x					x	x
		Maryland							x					x	x
		Massachusetts						x	x					x	x
		Michigan						x	x					x	x
		Minnesota						x	x	x				x	
		Mississippi						x						x	x

Continent	Country	State/region	Species present in the EU				Species absent in the EU								
			M. galloprovincialis	***M. urussovii***	***M. saltuarius***	***M. sutor***	***M. alternatus***	***M. carolinensis***	***M. marmorator***	***M. mutator***	***M. nitens***	***M. notatus***	***M. obtusus***	***M. scutellatus***	***M. titillator***
		Missouri						x							
		Nevada												x	
		New Hampshire							x					x	x
		New Jersey						x	x					x	x
		New Mexico												x	
		New York						x	x					x	x
		North Carolina						x	x					x	x
		North Dakota													x
		Ohio						x	x					x	x
		Oklahoma						x							
		Oregon											x	x	
		Pennsylvania						x	x					x	x
		Rhode Island							x					x	x
		South Carolina						x						x	x
		South Dakota													
		Tennessee						x						x	x
		Texas						x							x
		Utah												x	
		Vermont							x					x	x
		Virginia						x	x					x	x
		Washington											x	x	
		West Virginia												x	x
		Wisconsin						x	x					x	x
Asia	China	Anhui					x								
		Fujian					x								
		Guangdong					x								
		Guangxi					x								
		Guizhou					x								
		Hebei			x		x								
		Heilongjiang		x	x	x									
		Hubei					x								
		Hunan					x								
		Jiangsu					x								
		Jiangxi					x								
		Jilin	x	x	x	x	x								
		Liaoning		x		x									
		Neimenggu		x		x									
		Qinghai				x									
		Shaanxi					x								
		Shandong			x	x	x								
		Shanxi					x								
		Sichuan					x								

Continent	Country	State/region	Species present in the EU				Species absent in the EU								
			M. galloprovincialis	***M. urussovii***	***M. saltuarius***	***M. sutor***	***M. alternatus***	***M. carolinensis***	***M. marmorator***	***M. mutator***	***M. nitens***	***M. notatus***	***M. obtusus***	***M. scutellatus***	***M. titillator***
		Xianggang (Hong Kong)					x								
		Xinjiang					x								
		Yunnan					x								
		Zhejiang					x								
	Iran					x									
	Japan			x	x	x					x				
		Hokkaido					x								
		Honshu					x								
		Kyushu					x								
		Ryukyu Archipelago					x								
		Shikoku					x								
	Kazakhstan		x			x									
	Democratic People's Republic of Korea					x									
	Republic of Korea			x	x	x	x								
	Laos						x								
	Lebanon					x									
	Mongolia		x			x									
	Taiwan						x								
	Vietnam						x								
Europe (non EU)	Albania		x			x									
	Andorra					x									
	Armenia		x												
	Azerbaijan		x												
	Belarus		x			x									
	Bosnia and Herzegovina		x			x									
	Georgia		x			x									
	Macedonia		x												
	Moldova		x			x									
	Montenegro		x												
	Norway		x	x		x									
	Russia	Central Russia	x	x	x	x									
		Eastern Siberia	x	x		x									
		Far East	x			x									
		Northern Russia	x	x		x									
		Southern Russia	x	x		x									
		Western Siberia	x	x	x	x									

Continent	Country	State/region	Species present in the EU				Species absent in the EU								
			M. galloprovincialis	***M. urussovii***	***M. saltuarius***	***M. sutor***	***M. alternatus***	***M. carolinensis***	***M. marmorator***	***M. mutator***	***M. nitens***	***M. notatus***	***M. obtusus***	***M. scutellatus***	***M. titillator***
	Serbia		x			x									
	Switzerland		x		x	x									
	Turkey		x												
	Ukraine		x		x	x									

3.2.2. Pest distribution in the EU

> *Is the pest present in the EU territory? If present, is the pest widely distributed within the EU?*
>
> **Yes**, five *Monochamus* species are present in the EU (Table 3) but are also distributed in several non-EU countries (Table 2).

Table 3: Current distribution of *Monochamus species* in the 28 EU MS based on information from the EPPO Global Database and *Fauna Europaea*[(a)]

Country	*M. galloprovincialis*	*M saltuarius*	*M sartor*	*M. sutor*	*M. urussovii*
Austria	Present, no details	Present, no details	Present	Present, no details	–
Belgium	–	–	–	–	–
Bulgaria	Absent, intercepted only	–	Present	Present, no details	–
Croatia	Present, no details	–	Present	Present, no details	–
Cyprus	–	–	–	–	–
Czech Republic	Present, no details	–	Present	Present, no details	–
Denmark	Present, restricted distribution	–	–	Present, no details	–
Estonia	Present, no details	–	–	Present, no details	–
Finland	Present, widespread	–	–	Present, widespread	Present, restricted distribution
France	Present, widespread Corse: Present, no details	–	Present	Present, no details	–
Germany	Present, no details	Present, restricted distribution	Present	Present, no details	–
Greece	Present, no details	–	–	–	–
Hungary	Present, no details	–	Present	Present, no details	
Ireland	–	–	–	–	–
Italy	Present, no details Sicily: Present, no details	Present, restricted distribution	Present	Present, restricted distribution	–

Country	*M. galloprovincialis*	*M saltuarius*	*M sartor*	*M. sutor*	*M. urussovii*
Latvia	Present, no details	–	–	Present, no details	–
Lithuania	Present, no details	Present, no details	–	Present, no details	–
Luxembourg	–	–	–	–	–
Malta	–	–	–	–	–
The Netherlands	Present, restricted distribution	–	–	Present, no details	–
Poland	Present, no details	Present, no details	Present	Present, no details	Present, no details
Portugal	Present, widespread Madeira: Present, no details	–	–	–	–
Romania	Present, no details	–	Present	Present, no details	–
Slovak Republic	Present, no details	–	Present	Present, no details	–
Slovenia	Present, no details	–	Present	Present, no details	–
Spain	Present, widespread Balearic islands: Present, no details Canary islands: Present, few occurrences	–	–	Present, restricted distribution	–
Sweden	Present, no details	–	–	Present, no details	Present, no details
United Kingdom	Absent, intercepted only	–	–	Absent, intercepted only	–

–: Data not available.
(a): *M. rosenmuelleri*, listed in *Fauna Europaea* (2018), is not included in Table 3, as it is usually not considered as a species *per se.* Bezark (2018b), consider is as a subspecies (*Monochamus sutor rosenmuelleri* Cederhjelm 1798); Tavakilian and Chevillotte (2018), treat it as a synonym for *M. urussovii.*

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

Non-European *Monochamus* species are listed in Council Directive 2000/29/EC. Details are presented in Tables 4 and 5. It should be noted that some *Monochamus* species present in the EU territory have a wider distribution range that includes Asian countries where the PWN is present (China, Taiwan, Japan, Korea – see Appendix B). These species could be a pathway for PWN. However, import requirements in place for host plants of PWN and coniferous wood in general will also prevent the introduction of all *Monochamus* species present in third countries.

Table 4: *Monochamus* spp. in Council Directive 2000/29/EC

Annex I, Part A	**Harmful organisms whose introduction into, and spread within, all member states shall be banned**
Section I	**Harmful organisms not known to occur in any part of the community and relevant for the entire community**
(a)	Insects, mites and nematodes, at all stages of their development
	Species
14.	*Monochamus* spp. (non-European)

3.3.2. Legislation addressing the hosts of *Monochamus* spp

Monochamus spp. (non-European) are listed on Annex IAI, which implies they are regulated for all plant genera and commodities. Requirements for wood and bark are specified in Council Directive 2000/29/EC Annex IVAI 1.1, 1.2, 1.5, 1.6, 1.7 and 7.3.

3.3.3. Legislation addressing the organisms vectored by *Monochamus* spp. (Directive 2000/29/EC)

Table 5: Organisms vectored by *Monochamus* spp. in Council Directive 2000/29/EC

Annex I, Part A	**Harmful organisms whose introduction into, and spread within, all member states shall be banned**
Section II	**Harmful organisms known to occur in the community and relevant for the entire community**
(a)	Insects, mites and nematodes, at all stages of their development
	Species
0.01.	*Bursaphelenchus xylophilus* (Steiner and Bührer) Nickle et al.

Detection, containment and eradication measures for Pine Wood nematode and its vector *Monochamus* are specified in EU Commission Decision 2012/535/EU on emergency measures to prevent the spread within the Union of *Bursaphelenchus xylophilus* (Steiner et Buhrer) Nickle et al. (the pine wood nematode). These include: demarcating areas around infested areas, destruction of contaminated material, heat treatment of wood, bark and wood packaging material (56°C, 30 min), chipping wood waste (to pieces of 3 cm), hygiene protocol for forestry vehicles and transport conditions (timing and protection) of plants and wood and bark.

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

As stated in Section 3.1.2, the conifer-dwelling species attack trees of the genera *Pinus*, *Picea*, *Abies*, *Cedrus*, *Juniperus*, *Cryptomeria*, *Tsuga*, *Pseudotsuga*. A detailed list of the genera colonised by each species is given in Appendix B. Many of the commodities listed in Section 3.4.2 below are made of wood of these species.

3.4.2. Entry

Is the pest able to enter into the EU territory? If yes, identify and list the pathways!
Yes, non-EU *Monochamus* species able to enter the EU territory, as shown by their high interception records.

Possible pathways of entry are:

1) Wood[4] (including any wood products made from raw untreated coniferous wood)
2) Coniferous wood packaging material and dunnage
3) Particle wood and waste wood of host species of a size appropriate for larval survival
4) Finished wood products (e.g. upholstered furniture)
5) Live, long-lived adults can be transported in containers as hitchhikers.

There are existing requirements for pathways 1–3 (see Section 3.3.2).

Plants for planting are considered an unlikely pathway for non-EU *Monochamus* as adults attack large weakened or dead trees.

There is trade of coniferous wood products into the EU from countries where non-EU *Monochamus* species are present. Although there are strict requirements for wood packaging material in trade in place in the EU (following ISPM 15), there are interceptions of *Monochamus* on this commodity. There are 124 records of interception of *Monochamus* species in the Europhyt database (from 1998 to 19 June 2018). All the interception records are for wood packaging material or dunnage. There was

[4] In line with the EPPO Study on wood commodities other than round wood, sawn wood and manufactured items (EPPO, 2015) the definition of wood includes firewood which is thus included in this pathway.

one case in England in 2013, of half a dozen *M. alternatus*, some of which living adults, found by a member of the public in a recently purchased chair (Hodgetts et al., 2016).

3.4.3. Establishment

> *Is the pest able to become established in the EU territory?*
>
> **Yes**, the host plants are widely present, and the climatic conditions of the areas of origin occur in parts of the EU territory. Biotic and abiotic conditions are thus favourable for establishment.

3.4.3.1. EU distribution of main host plants

Monochamus spp. feeding on conifers attack mostly *Pinus* spp. and other Pinaceae genera (*Abies, Larix, Picea, Cedrus, Juniperus, Cryptomeria*). These are distributed throughout the EU territory (Figure 1).

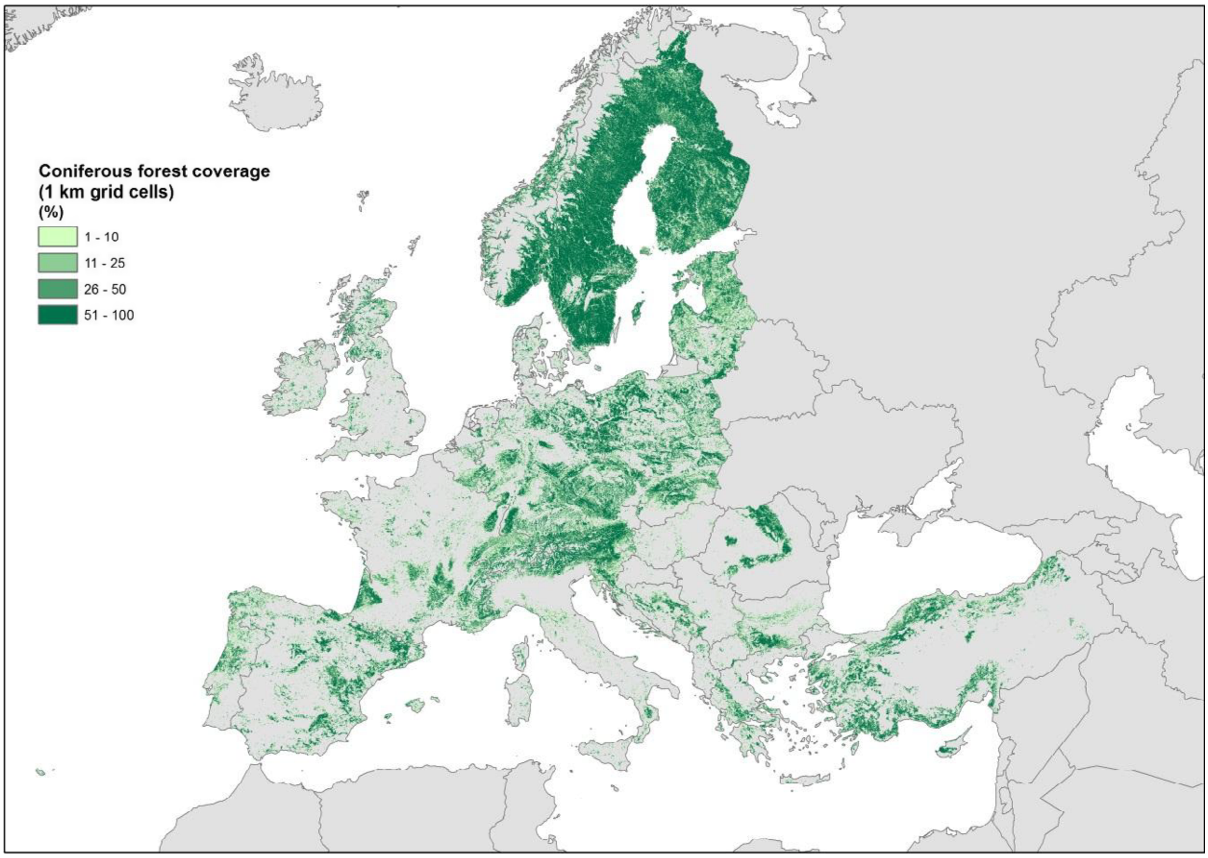

Figure 1: The cover percentage of coniferous forests in Europe with a range of values from 0 to 100 at 1 km resolution (source: Corine Land Cover year 2012 version 18.5 by EEA)

3.4.3.2. Climatic conditions affecting establishment

There are several species in the genus *Monochamus*, already present in the EU. Temperature requirements of the different species within the genus are expected to vary. However, for the non-EU *Monochamus* species occurring in temperate regions of the world no constraints on climatic conditions are expected, as specific life-history metrics seem to match closely among *Monochamus* species (Akbulut et al., 2017). Because suitable hosts occur across the EU, biotic and abiotic conditions are favourable for establishment.

3.4.4. Spread

Is the pest able to spread within the EU territory following establishment? How?

Yes, the pest is able to spread by flight as well as by man assisted transportation of infested material.

RNQPs: Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects?

No, plants for planting are not considered a significant pathway for spread.

The spread capacities of *Monochamus* species have been assessed using three different techniques: Field experiments (mainly mark-release-recaptures), flightmill experiments and modelling based on epidemiological data.

Field experiments. In Japan, Kobayashi et al. (1984), based on the distance between newly diseased trees and the site where infested logs were introduced, concluded that *M. alternatus* adults can disperse up to 3.3 km. In Spain, in mark–release–recapture experiments by Mas et al. (2013) *M. galloprovincialis* adults flew a maximum distance of 22.1 km, with ca 2% of the beetles flying further than 3 km. In other mark–release–recapture experiments, also in Spain, 5% of the beetles in one release flew ca 5 km. An interesting result from these latter trials was that the beetles were sometimes recaptured quite late (up to 105 days) after their release.

Flightmill experiments. In the US, Akbulut and Linit (1999) reported that *M. carolinensis* females flew up to 10 km. In France, *M. galloprovincialis* females, fed with small pine twigs between flying sessions, were able to fly cumulatively an average of 16 km, with a maximum of 44 km during their lifespan. In Austria, Putz et al. (2016), found that *M. sartor* cumulatively flew a mean distance of 7.5 km during their lifespan.

Models. Robinet et al. (2009) analysed the spread of the PWN in China during the period 1982-2005. They found that short distance spread averaged 7.5 km/year. In Japan, Osada et al. (2018) analysed historical records of PWD infection and vector abundance across 403 municipalities in northern Honshu during the period 1980–2011, and found that the yearly local spread of PWD (due to vector movements) was 2.2–3.6 km. Analysing the spread of PWD in Portugal between 2005 and 2015, de la Fuente et al. (2018) found a yearly spread into adjacent areas (thus due to vector movements) of 5.3 km in the average, with a maximum of 8.3 km.

The spread capacities of the various *Monochamus* species tested so far seem thus to allow single flights of a few kilometres, with cumulated flights over one beetle's lifespan reaching several tens of kilometres. This flight capacity is of course complemented by man-assisted spread, which could cover hundreds or thousands of kilometres. In their model regarding the PWN in China, Robinet et al. (2009) found that long-distance spread constituted more than 90% of the data, with an average distance of 111–339 km, depending on the calculation method.

3.5. Impacts

Would the pests' introduction have an economic or environmental impact on the EU territory?

Yes, the introduction of the PWN vectored by *Monochamus* beetles in conifer forests of Eastern Asia and Portugal has caused massive mortality.

RNQPs: Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?[5]

No, as plants for planting are not the main pathway for *Monochamus* spp.

Monochamus spp. do not qualify as pests by themselves, as they attack weakened or dead trees. However, as a vector of PWN they contribute to epidemic outbreaks of pine wilt disease (Togashi, 1988; Yoshimura et al., 1999). The nematode has caused severe damage to pine forests in East Asia and in Europe and enormous further impacts in Europe are foreseen in terms of forest stock losses and social impact (Soliman et al., 2012). The introduction of non-EU *Monochamus* species could facilitate the introduction and spread of PWN in the EU.

[5] See Section 2.1 on what falls outside EFSA's remit.

3.6. Availability and limits of mitigation measures

> *Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?*
>
> **Yes**, there are import prohibitions in place for several coniferous plants and special requirements are specified for the trade of wood of conifers. Detection, containment and eradication measures for Pine Wood nematode and its vector *Monochamus* are specified in EU emergency measures 2012/535/EU (for details see Section 3.3). Additional control measures are discussed in section 3.6.1.
>
> *RNQPs: Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?*
>
> **No**, as plants for planting are not the main pathway for *Monochamus* spp.

3.6.1. Identification of additional measures

An overview of the possible risk mitigating measures to prevent the introduction, spread and impact of *Monochamus* is presented in Appendices C and D. Additional control and/or supporting measures that could be considered were selected from this list.

3.6.1.1. Additional control measures

The following additional control measures (i.e. measures that have a direct effect on pest abundance) were identified (Table 6).

Table 6: Selected control measures (a full list is available in EFSA PLH Panel et al., 2018) for pest entry/establishment/spread/impact in relation to currently unregulated hosts and pathways. Control measures are measures that have a direct effect on pest abundance

Information sheet title (with hyperlink to information sheet if available)	Control measure summary	Risk component (entry/establishment/spread/impact)
Physical treatments on consignments or during processing	This information sheet deals with the following categories of physical treatments: irradiation/ionisation; mechanical cleaning (brushing, washing); sorting and grading, and; removal of plant parts (e.g. debarking wood). This information sheet does not address: heat and cold treatment (information sheet 1.14); roguing and pruning (information sheet 1.12). Specifically: debarking to remove early life stages of *Monochamus* spp.	Entry

3.6.1.2. Additional supporting measures

The following additional supporting measures (i.e. measures or procedures supporting the choice of appropriate risk reduction options that do not directly affect pest abundance) were identified (Table 7).

Table 7: Selected supporting measures (a full list is available in EFSA PLH Panel, 2018) in relation to currently unregulated hosts and pathways. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk reduction options that do not directly affect pest abundance

Information sheet title (with hyperlink to information sheet if available)	Supporting measure summary	Risk component (entry/establishment/spread/impact)
Laboratory testing	Examination, other than visual, to determine if pests are present using official diagnostic protocols. Diagnostic protocols describe the minimum requirements for reliable diagnosis of regulated pests. Specifically: DNA barcoding of larval stages of *Monochamus* spp.	Entry

3.6.1.3. Biological or technical factors limiting the feasibility and effectiveness of measures to prevent the entry, establishment and spread of the pest

- Methyl bromide used for the treatment of wood by fumigation and pressure impregnation will be phased out in the future following the Montreal protocol in 1987.
- Cleaning and disinfection of facilities, tools and machinery do not target *Monochamus*, but PWN.
- Debarking wood does not remove the larvae present in the sapwood.
- For the treatment of wood, bark and wood packaging material, ISPM 15 is not always applied rigorously.
- The high number of traps needed for mass trapping to have an impact on the population.
- For visual examination, larvae within the wood cannot always be spotted
- DNA barcoding has been used to identify *Monochamus* spp. larvae to species level, but it has not been verified for all species so far.

3.7. Uncertainty

- The status of eight *Monochamus* species as PWN vectors is not established to date.
- Three species absent in the EU and proven vectors of PWN, *M. alternatus*, *M. guerryi*, *M. subfasciatus*, also colonise some non-conifer tree species, therefore extending the pathways to non-coniferous wood, packaging material and finished products.
- A clarification of the taxonomic status of many species and subspecies, particularly *M. carolinensis* (= *M. dentator*) and *M. rosenmuelleri* (= *M. sutor rosenmuelleri*) is necessary.
- For broad-leaved trees, there are some reports of the status of *Monochamus* species as vectors of fungal tree pathogens such as Dutch elm disease, chestnut blight, oak wilt and hypoxylon canker. This has not been assessed in this pest categorisation.
- The impact of species attacking non-coniferous trees should be clarified.

4. Conclusions

Monochamus spp. do not qualify as pests by themselves, as they attack weakened or dead trees (Akbulut and Stamps, 2011; Akbulut et al., 2017; Ethington, 2015; Hellrigl, 1970). However, 13 species in the genus have been identified as vectors of the PWN, *Bursaphelenchus xylophilus*, responsible for the PWD worldwide (Akbulut and Stamps, 2011), and which is present in Portugal and transient in Spain (EPPO, 2018).

Two groups have thus been considered for the purpose of this pest categorisation.

The first group (Table 8) comprises the 16 non-EU species colonising conifer trees. These include the nine species known as vectors of the PWN (*M. alternatus, M. carolinensis, M. marmorator, M. mutator, M. nitens, M. notatus, M. obtusus, M. scutellatus* and *M. titillator*) and the seven other species colonising conifers and which might also be vectors of the PWN (*M. basifossulatus*; *M. clamator*; *M. grandis*; *M. guerryi*; *M. impluviatus*; *M. subfasciatus*; and *M. talianus*). Four additional species (*M. galloprovincialis*, *M. saltuarius*; *M. sutor* and *M. urussovii*) are present in the EU but are also distributed in third countries in Europe and Asia. Species of the first group are listed in Appendix B.

The second group (Table 9) comprises all the species (approximately 80) colonising non-conifer trees. None of these species are present in the EU. Since these species do not vector the PWN, this pest categorisation does not discuss them in detail.

Table 8: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column) for the species living on conifers (*M. alternatus, M. basifossulatus*; *M. carolinensis, M. clamator*; *M. grandis*; *M. guerryi*; *M. impluviatus*; *M. marmorator, M. mutator, M. nitens, M. notatus, M. obtusus, M. scutellatus, M. subfasciatus*; *M. talianus, M. titillator*)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of the species of the genus *Monochamus* is generally well established. The different species can be identified using taxonomic keys at the national or regional level	The identity of the species of the genus *Monochamus* is generally well established. The different species can be identified using taxonomic keys at the national or regional level	No taxonomic key at the world level is currently available. There are some discrepancies in the literature regarding some species in the genus
Absence/ presence of the pest in the EU territory (Section 3.2)	There are 16 *Monochamus* species attacking coniferous trees, absent from the EU of which nine are known vectors of the PWN	There are 16 *Monochamus* species attacking coniferous trees, absent from the EU of which nine are known vectors of the PWN	
Regulatory status (Section 3.3)	Non-European *Monochamus* spp. are listed on Annex IAI. They are regulated for all plant genera and commodities. There are import requirements in place for coniferous wood and wood products	Non-European *Monochamus* spp. are listed on Annex IAI. They are regulated for all plant genera and commodities. There are import requirements in place for coniferous wood and wood products	
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	The pests are able to enter into, establish in, and spread within the EU territory. The main pathways are coniferous wood, coniferous wood packaging material and dunnage, particle wood and waste wood of conifers, finished wood products, hitchhiking. Spread can also be achieved by natural flight	Not applicable. Plants for planting are not a pathway	Three species absent in the EU, *M. alternatus*, *M. guerryi*, *M. subfasciatus*, also colonise some non-conifer tree species, therefore extending the pathways to non-coniferous wood, packaging material and finished products
Potential for consequences in the EU territory (Section 3.5)	The pests' introduction could have an important economic or environmental impact on pines in the EU territory as they are potential vectors the PWN	Not applicable. Plants for planting are not a pathway	The status of seven *Monochamus* species as PWN vectors is not established to date
Available measures (Section 3.6)	Phytosanitary measures are available to reduce the likelihood of entry into the EU, e.g. prohibition of conifer plants and requirements for conifer wood, wood products and wood packaging material	Not applicable. Plants for planting are not a pathway	

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Conclusion on pest categorisation (Section 4)	The 16 species attacking conifer trees and that are potential vectors of PWN, do satisfy all the criteria that are within the remit of EFSA to assess to be considered as Union quarantine pests	Not applicable. Plants for planting are not a pathway	
Aspects of assessment to focus on/ scenarios to address in future if appropriate	Three species absent in the EU, *M. alternatus*, *M. guerryi*, *M. subfasciatus*, also colonise some non-conifer tree species, therefore extending the pathways to non-coniferous wood, packaging material and finished products A clarification of the taxonomic status of two species in this group [*M. carolinensis* (= *M. dentator*); *M. rosenmuelleri* (=*M. sutor rosenmuelleri*)] is necessary The status of seven *Monochamus* species as PWN vectors needs to be clarified		

Table 9: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column) for the species living on non-conifers

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of the species of the genus *Monochamus* is generally well established. The different species can be identified using taxonomic keys at the national or regional level	The identity of the species of the genus *Monochamus* is generally well established. The different species can be identified using taxonomic keys at the national or regional level	No taxonomic key at the world level is currently available. There are some discrepancies in the literature regarding some species in the genus
Absence/ presence of the pest in the EU territory (Section 3.2)	All the species in this group are absent from the EU territory	All the species in this group are absent from the EU territory	
Regulatory status (Section 3.3)	Non-European *Monochamus* spp. are listed on Annex IAI. They are regulated for all plant genera and commodities	Non-European *Monochamus* spp. are listed on Annex IAI. They are regulated for all plant genera and commodities	
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	The pests are able to enter into, establish in, and spread within the EU territory. The main pathways are non-coniferous wood, non-coniferous wood packaging material and dunnage, particle wood and waste wood, finished non-coniferous wood products, hitchhiking. Spread can also be achieved by natural flight	Not applicable. Plants for planting are not a pathway	

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Potential for consequences in the EU territory (Section 3.5)	The pests' introduction is not expected to have an important economic or environmental impact on non-conifer trees in the EU territory	Not applicable. Plants for planting are not a pathway	The status of *Monochamus* species as vectors of fungal tree pathogens such as Dutch elm disease, chestnut blight, oak wilt, and hypoxylon canker needs to be further investigated
Available measures (Section 3.6)	Non-European *Monochamus* spp. are listed on Annex IAI. They are regulated for all plant genera and commodities, but specific requirements for certain broad leaf genera may not be specified	Not applicable. Plants for planting are not a pathway	It is uncertain if the current legislation embraces all the host plants of non-EU *Monochamus* species attacking non-coniferous trees
Conclusion on pest categorisation (Section 4)	The many species in this group do not satisfy all the criteria that are within the remit of EFSA to assess to be considered as Union quarantine pests, as their introduction is not expected to have an important economic or environmental impact on non-conifer trees in the EU territory	Not applicable. Plants for planting are not a pathway	The impact of species attacking non-coniferous trees should be clarified
Aspects of assessment to focus on/ scenarios to address in future if appropriate	A clarification of the taxonomic status of many species and subspecies in this group is necessary. The status of *Monochamus* species as vectors of fungal tree pathogens needs to be further investigated		

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Abbreviations

DG SANTÉ	Directorate General for Health and Food Safety
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization

IPPC	International Plant Protection Convention
MS	Member State
PLH	EFSA Panel on Plant Health
PWD	pine wood nematode
PWN	pine wilt disease
RNQP	Regulated Non-Quarantine Pest
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

Appendix A – *Monochamus* species and subspecies according to the two world catalogues

Species/subspecies	Continent	T[(a)]	B[(b)]	Species	Subspp
Monochamus abruptus Holzschuh 2015	Asia	X	X	X	
Monochamus affinis Breuning, 1938	Africa	X	X	X	
Monochamus alboapicalis (Pic, 1934)	Asia	X		X	
Monochamus alboapicalis Pic, 1934	Asia		X	X	
Monochamus alboapicalis strandiellus Breuning 1935	Asia		X		X
Monochamus alternatus (Hope, 1843)	Asia	X	X	X	
Monochamus alternatus alternatus Hope 1842	Asia		X		X
Monochamus alternatus endai Makihara 2004	Asia	X	X		X
Monochamus alternatus tesserula White 1858	Asia		X		X
Monochamus asper Breuning, 1935	Asia	X	X	X	
Monochamus atrocoeruleogriseus Gilmour 1956	Africa	X	X	X	
Monochamus balteatus Aurivillius, 1903	Africa	X	X	X	
Monochamus basifossulatus Breuning 1938	Asia	X	X	X	
Monochamus basigranulatus Breuning, 1952	Africa	X	X	X	
Monochamus basigranulatus subtuberosus Breuning 1965	Africa		X		X
Monochamus basilewskyi Breuning, 1952	Africa	X	X	X	
Monochamus bialbomaculatus Breuning, 1948	Africa	X	X	X	
Monochamus bimaculatus (Gahan, 1888)	Asia	X	X	X	
Monochamus bimaculatus ingranulatus Pic 1925	Asia		X		X
Monochamus binigricollis Breuning, 1965	Asia	X	X	X	
Monochamus binigromaculatus Breuning 1959	Asia	X	X	X	
Monochamus blairi (Breuning, 1936)	South America	X	X	X	
Monochamus bootangensis Breuning 1947	Asia	X	X	X	
Monochamus borchmanni Breuning 1959	Asia	X	X	X	
Monochamus burgeoni Breuning 1935	Africa	X	X	X	
Monochamus burgeoni nigrosparsus Breuning 1938	Africa		X		X
Monochamus carolinensis (Olivier, 1792)	North America		X	X	
Monochamus carolinensis caroliniensis Olivier 1795	North America		X		X
Monochamus carolinensis dentator Fabricius 1792	North America		X		X
Monochamus carolinensis minor LeConte 1873	North America		X		X
Monochamus clamator (LeConte, 1852)	North America	X	X	X	
Monochamus clamator clamator (LeConte, 1852)	North America		X		X
Monochamus clamator latus Casey 1924	North America	X	X		X
Monochamus clamator linsleyi Dillon & Dillon 1941	North America	X	X		X
Monochamus clamator maculosus Horn 1885	North America		X		X
Monochamus clamator nevadensis Dillon & Dillon 1941	North America	X	X		X
Monochamus clamator oregonensis Casey 1913	North America		X		X
Monochamus clamator rubigineus (Bates, 1880)	North America	X			X
Monochamus clamator rubigineus Bates 1880	North America		X		X
Monochamus clamator strenuus Casey 1913	North America		X		X
Monochamus conradti Breuning 1961	Africa	X	X	X	
Monochamus convexicollis Gressitt 1942	Asia	X	X	X	
Monochamus dayremi Breuning 1935	Africa	X	X	X	
Monochamus densepunctatus Breuning 1980	Asia	X	X	X	
Monochamus dentator (Fabricius, 1793) (= *M. carolinensis*)	North America	X		X	
Monochamus desperatus fredericus White 1858	New Guinea		X		X
Monochamus desperatus Thompson, 1857	New Guinea	X	X	X	

Species/subspecies	Continent	T(a)	B(b)	Species	Subspp
Monochamus fisheri (Breuning, 1944)	Asia	X		X	
Monochamus fisheri Breuning 1944	Asia		X	X	
Monochamus fisheri variegatus Fisher 1935	Asia		X		X
Monochamus flavosignatus Breuning 1947	Asia	X	X	X	
Monochamus flavovittatus Breuning 1935	Africa	X	X	X	
Monochamus foraminosus Holzschuh 2015	Asia	X	X	X	
Monochamus foveatus Breuning 1961	Asia	X	X	X	
Monochamus foveolatus Hintz 1911	Africa	X	X	X	
Monochamus fruhstorferi Breuning, 1964	Asia	X		X	
Monochamus galloprovincialis (Olivier, 1795)	Europe	X	X	X	
Monochamus galloprovincialis cinerascens (Motschulsky, 1860)	Europe	X	X		X
Monochamus galloprovincialis galloprovincialis (Olivier, 1795)	Europe		X		X
Monochamus galloprovincialis lignator Krynicki 1832	Europe		X		X
Monochamus galloprovincialis nitidior Abeille 1870	Europe		X		X
Monochamus galloprovincialis parendeli Thery 1891	Europe		X		X
Monochamus galloprovincialis pistor (Germar, 1818)	Europe	X	X		X
Monochamus galloprovincialis sibiricus Pic 1908	Europe		X		X
Monochamus galloprovincialis subrufopubens Pic 1912	Europe		X		X
Monochamus galloprovincialis tauricola Pic 1912	Europe	X	X		X
Monochamus galloprovincialis transitivus Lazarev, 2017	Europe	X			X
Monochamus galloprovincialis unifasciatus Pic 1905	Europe		X		X
Monochamus gardneri Breuning 1938	Asia	X	X	X	
Monochamus grandis Waterhouse 1881	Asia	X	X	X	
Monochamus granulipennis Breuning 1949	Africa	X	X	X	
Monochamus gravidus multimaculatus Pic 1933	Asia		X		X
Monochamus gravidus Pascoe 1858	Asia	X	X	X	
Monochamus guerryi Pic 1903	Asia	X	X	X	
Monochamus guttulatus Gressitt 1951	Asia	X	X	X	
Monochamus guttulatus guttatus Blessig 1873	Asia		X		X
Monochamus hiekei Breuning 1964	Asia	X	X	X	
Monochamus impluviatus impluviatus Motschulsky 1859	Europe, Asia		X		X
Monochamus impluviatus Motschulsky, 1859	Europe, Asia	X	X	X	
Monochamus impluviatus silvicola Wang 2003	Europe, Asia		X		X
Monochamus itzingeri (Breuning, 1935)	Asia	X	X	X	
Monochamus jordani Nonfried 1894	Asia	X	X	X	
Monochamus karlitzingeri Tavakilian & Jiroux, 2015	Asia	X		X	
Monochamus kaszabi Heyrovsky 1955	Asia	X	X	X	
Monochamus kinabaluensis Hudepohl 1966	Asia	X	X	X	
Monochamus kivuensis Breuning 1938	Africa	X	X	X	
Monochamus laevis Jordan 1903	Africa		X	X	
Monochamus lamottei Lepesme & Breuning 1952	Africa	X	X	X	
Monochamus latefasciatus Breuning, 1944	Asia	X	X	X	
Monochamus latefasciatus unifasciatus Breuning 1935	Asia		X		X
Monochamus lepesmei Breuning 1956	Africa	X	X	X	
Monochamus luteodispersus Pic 1927	Asia	X	X	X	
Monochamus maculosus (Haldeman, 1847) 1847	North America		X	X	
Monochamus maculosus mutator LeConte in Agassiz 1850	North America		X		X
Monochamus marmorator acutus Lacordaire 1869	North America		X		X

Species/subspecies	Continent	T[(a)]	B[(b)]	Species	Subspp
Monochamus marmorator fautor LeConte 1852	North America		X		X
Monochamus marmorator Kirby, 1837	North America	X	X	X	
Monochamus maruokai Hayashi 1962	Asia	X	X	X	
Monochamus masaoi Kusama & Takakuwa 1984	Asia	X	X	X	
Monochamus mausoni Breuning 1950	Asia	X	X	X	
Monochamus mbai Lepesme & Breuning 1953	Africa	X	X	X	
Monochamus mediomaculatus Breuning 1935	Asia	X	X	X	
Monochamus mexicanus (Breuning, 1950)	North America	X	X	X	
Monochamus mutator LeConte, 1850	North America	X		X	
Monochamus nigromaculatus Gressitt 1942	Asia	X	X	X	
Monochamus nigromaculicollis Breuning 1974	Asia	X	X	X	
Monochamus nigroplagiatus Breuning 1935	Asia	X	X	X	
Monochamus nigroplagiatus ochrescens Breuning 1944	Asia		X		X
Monochamus nigrovittatus Breuning 1938	Africa	X	X	X	
Monochamus nigrovittatus leonensis Breuning 1956	Africa		X		X
Monochamus nitens Bates 1884	Asia	X	X	X	
Monochamus nitens griseonotatus Pic 1931	Asia		X		X
Monochamus notatus (Drury, 1773)	North America	X	X	X	
Monochamus notatus confusor Kirby in Richardson 1837	North America		X		X
Monochamus notatus morgani Hopping 1945	North America		X		X
Monochamus obtusus Casey, 1891	North America	X	X	X	
Monochamus obtusus fulvomaculatus Linsley, 1933	North America	X	X		X
Monochamus obtusus obtusus Casey 1891	North America		X		X
Monochamus ochreomarmoratus Breuning 1960	Africa	X	X	X	
Monochamus ochreopunctatus Breuning 1980	Asia	X	X	X	
Monochamus ochreosparsus Breuning 1959	Africa	X	X	X	
Monochamus ochreosticticus Breuning 1938	Africa	X	X	X	
Monochamus ochreosticticus flavoguttatus Breuning 1956	Africa		X		X
Monochamus olivaceus Breuning 1935	Africa	X	X	X	
Monochamus pentagonus Baguena 1952	Africa	X	X	X	
Monochamus principis Breuning 1956	Africa	X	X	X	
Monochamus quadriplagiatus Breuning 1935	Africa	X	X	X	
Monochamus rectus Holzschuh 2015	Asia	X	X	X	
Monochamus regularis (Aurivillius, 1924)	Asia	X	X	X	
Monochamus regularis granulosus Breuning & de Jong 1941	Asia		X		X
Monochamus rhodesianus Gilmour 1956	Africa	X	X	X	
Monochamus roveroi Teocchi, Sudre & Jiroux, 2015	Africa	X		X	
Monochamus rubigineus Fairmaire 1892	Africa		X	X	
Monochamus rubiginosus Teocchi, Sudre & Jiroux, 2014	Africa	X		X	
Monochamus saltuarius Gebler 1830	Europe	X	X	X	
Monochamus saltuarius occidentalis Sláma, 2017	Europe	X			X
Monochamus sargi (Bates, 1885)	North America	X	X	X	
Monochamus sartor (Fabricius, 1787)	Europe, Asia	X	X	X	
Monochamus sartor fleischeri Heyrovsky 1966	Europe, Asia		X		X
Monochamus sartor mulsanti Seidl 1891	Europe, Asia		X		X
Monochamus sartor okenianus Gistel 1857	Europe, Asia		X		X
Monochamus scutellatus (Say, 1824)	North America	X	X	X	
Monochamus scutellatus monticola Casey 1913	North America		X		X
Monochamus scutellatus oregonensis (LeConte, 1873)	North America	X	X		X

Species/subspecies	Continent	T[(a)]	B[(b)]	Species	Subspp
Monochamus scutellatus resutor Kirby in Richardson 1837	North America		X		X
Monochamus semicirculus Baguena 1952	Africa	X	X	X	
Monochamus semigranulatus Pic 1925	Asia	X	X	X	
Monochamus serratus Gahan 1906	Asia	X	X	X	
Monochamus shembaganurensis Breuning 1979	Asia	X	X	X	
Monochamus similis Breuning 1938	Africa	X	X	X	
Monochamus sparsutus (Fairmaire, 1889)	Asia	X	X	X	
Monochamus sparsutus dubius Gahan 1895	Asia		X		X
Monochamus sparsutus fascioguttatus Gressitt 1938	Asia		X		X
Monochamus sparsutus luteovittatus Breuning 1944	Asia		X		X
Monochamus sparsutus sintikensis Matsushita 1939	Asia		X		X
Monochamus sparsutus sparsenotatus Pic 1920	Asia		X		X
Monochamus subconvexicollis Breuning 1967	Asia	X	X	X	
Monochamus subcribosus Breuning 1950	Africa	X	X	X	
Monochamus subfasciatus Bates 1873	Asia	X	X	X	
Monochamus subfasciatus fasciatoguttatus Gressitt 1938	Asia		X		X
Monochamus subfasciatus kumageinsularis Hayashi, 1962	Asia	X	X		X
Monochamus subfasciatus meridianus Hayashi, 1955	Asia	X	X		X
Monochamus subfasciatus shikokuensis Breuning, 1956	Asia	X	X		X
Monochamus subfasciatus subfasciatus Pic 1902	Asia		X		X
Monochamus subgranulipennis Breuning 1974	Asia	X	X	X	
Monochamus subtrangularis Breuning 1972	Asia	X	X	X	
Monochamus sutor (Linnaeus, 1758)	Europe, Asia	X	X	X	
Monochamus sutor atomarius DeGeer 1775	Europe, Asia		X		X
Monochamus sutor fuscomaculatus Petri 1912	Europe, Asia		X		X
Monochamus sutor heinrothi Cederhjelm 1798	Europe, Asia		X		X
Monochamus sutor hybridus Petri 1912	Europe, Asia		X		X
Monochamus sutor longulus Pic 1898	Europe, Asia	X	X		X
Monochamus sutor obscurior Abeille 1869	Europe, Asia		X		X
Monochamus sutor pellio Germar 1818	Europe, Asia		X		X
Monochamus sutor rosenmuelleri Cederhjelm 1798	Europe, Asia		X		X
Monochamus sutor sutor (Linnaeus, 1758)	Europe, Asia		X		X
Monochamus taiheizanensis Mitono 1943	Asia	X	X	X	
Monochamus talianus Pic 1912	Asia	X	X	X	
Monochamus titillator (Fabricius, 1775)	North America	X	X	X	
Monochamus titillator angusticollis Casey 1913	North America		X		X
Monochamus titillator obesus Casey 1924	North America		X		X
Monochamus tonkinensis Breuning 1935	Asia	X	X	X	
Monochamus transvaaliensis Gilmour 1956	Africa	X	X	X	
Monochamus unicolor Breuning 1939	Africa		X	X	
Monochamus urussovii (Fischer-Waldheim, 1806)	Europe, Asia	X	X	X	
Monochamus urussovii quadrimaculatus Motschulsky 1845	Europe, Asia		X		X
Monochamus urussovii shaufussi Pic 1912	Europe, Asia		X		X
Monochamus verticalis Fairmaire 1901	Africa	X	X	X	
Monochamus villiersi Breuning 1960	Asia	X	X	X	

(a): T: Tavakilian and Chevillotte (2018) - http://titan.gbif.fr/sel_genre2.php; B: Bezark (2018a,b) - https://apps2.cdfa.ca.gov/publicApps/plant/bycidDB/wdefault.aspUnknownw=n; https://apps2.cdfa.ca.gov/publicApps/plant/bycidDB/wresults.aspUnknownw=o.
(b): See Section 2.1 on what falls outside EFSA's remit.

Appendix B – Host plants and geographic distribution of non-EU *Monochamus* spp. attacking conifers (data from the two world catalogues pooled; *Pinus* underlined)

Species/ subspecies	Host plants	Geographic distribution	Vector of PWN
M. alternatus	*Juniperus; Quercus; Abies; Cedrus deodara; Cedrus libani; Larix; Picea; Pinus; Malus; Morinda umbellata; Cryptomeria japonica*	China; Taiwan; Vietnam; Japan; Korea; Laos	X
M. basifossulatus	*Pinus*	India; Nepal; China	
M. carolinensis (= *M. dentator*)	*Pinus*	North America	X
M. clamator	*Abies, Pinus, Pseudotsuga menziesii*	North America	
M. grandis	*Abies; Larix; Picea; Pinus; Tsuga*	Japan	
M. guerryi	*Castanea, Quercus, Pinus, Malus*	China, Indochina	
M. impluviatus	*Larix, Pinus*	Europe (Urals), Mongolia, Russia (Siberia, Sakhalin), Northern China	
M. marmorator[(a)]	*Abies, Picea*	North America	X
M. mutator	*Pinus*	North America	X
M. nitens[(b)]	*Abies, Larix, Picea*	Japan	X
M. notatus	*Abies, Pinus, Pseudotsuga menziesii*	North America	X
M. obtusus	*Abies, Pinus, Pseudotsuga menziesii*	USA	X
M. scutellatus	*Abies, Picea, Larix, Pinus, Pseudotsuga menziesii, Tsuga*	North America	X
M. subfasciatus	*Aralia; Kalopanax; Alnus; Betula; Cornus; Carpinus; Mallotus; Robinia; Castanea; Fagus; Quercus; Juglans; Platycarya; Pterocarya; Clerodendrum; Machilus; Morus; Fraxinus; Pinus; Podocarpus; Hovenia; Malus; Prunus; Citrus;* Salicaceae; *Picrasma; Stachyurus; Staphylea; Oreocnide*	Japan; China	
M. talianus	*Pinus*	China (Yunnan)	
M. titillator	*Abies, Picea, Pinus*	North America	X

(a): *M. marmorator* and *M. nitens* are not recorded on *Pinus* spp. However, *M. nitens* is a known vector of the PWN (Linit, 1988).
(b): T: Tavakilian and Chevillotte (2018) - http://titan.gbif.fr/sel_genre2.php; B: Bezark (2018a,b) - https://apps2.cdfa.ca.gov/publicApps/plant/bycidDB/wdefault.aspUnknownw=n; https://apps2.cdfa.ca.gov/publicApps/plant/bycidDB/wresults.aspUnknownw=o.