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Pest categorisation of *Gremmeniella abietina*

EFSA Panel on Plant Health (PLH),
Michael Jeger, Claude Bragard, David Caffier, Thierry Candresse, Elisavet Chatzivassiliou, Katharina Dehnen-Schmutz, Gianni Gilioli, Jean-Claude Gregoire, Josep Anton Jaques Miret, Alan MacLeod, Maria Navajas Navarro, Björn Niere, Stephen Parnell, Roel Potting, Trond Rafoss, Vittorio Rossi, Gregor Urek, Ariena Van Bruggen, Wopke Van der Werf, Jonathan West, Stephan Winter, Johanna Boberg, Paolo Gonthier and Marco Pautasso

Abstract

Following a request from the European Commission, the EFSA Plant Health (PLH) Panel performed a pest categorisation of *Gremmeniella abietina*, a well-defined species and distinguishable fungus of the family Godroniaceae. The species *G. abietina* includes several varieties, races and biotypes that are found in different geographical locations, on different hosts and that vary in aggressiveness. The pathogen causes diseases on *Pinus* species and other conifers such as *Abies* spp., *Picea* spp., *Larix* spp. and *Pseudotsuga* spp. known as Scleroderris canker in North America and Brunchorstia dieback in Europe. *G. abietina* has been reported from 19 EU Member States, without apparent ecoclimatic factors limiting establishment. The pathogen is a protected zone (PZ) quarantine pest (Annex IIB) for Ireland and the UK (Northern Ireland). The main European hosts are widespread throughout most of the EU and have been frequently planted in the PZ. The main means of spread are wind-blown ascospores, rain-splashed conidia, plants for planting and traded Christmas trees. Given that *G. abietina* is most damaging to species that are grown towards the limit of their range, impacts can be expected in the PZ, should the pathogen be introduced there. Risk reduction options include selection of disease-free planting material, nursery inspections, selection of planting sites at some distance from infested plantations, appropriate spacing between plants and thinning. The main uncertainties concern the indeterminate endophytic stage of the fungus, the pathogen distribution and the future taxonomic status of *G. abietina*, given its intraspecific diversity. All the criteria assessed by the Panel for consideration as potential PZ quarantine pest are met. The criterion of plants for planting being the main pathway for spread for regulated non-quarantine pests is not met: plants for planting are only one of the means of spread of the pathogen.

Keywords: European Union, forest pathology, pest risk, plant health, plant pest, quarantine, tree diseases

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Correspondence: alpha@efsa.europa.eu

Panel members: Claude Bragard, David Caffier, Thierry Candresse, Elisavet Chatzivassiliou, Katharina Dehnen-Schmutz, Gianni Gilioli, Jean-Claude Gregoire, Josep Anton Jaques Miret, Michael Jeger, Alan MacLeod, Maria Navajas Navarro, Björn Niere, Stephen Parnell, Roel Potting, Trond Rafoss, Vittorio Rossi, Gregor Urek, Ariena Van Bruggen, Wopke Van der Werf, Jonathan West and Stephan Winter.

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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.

[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)
Ips duplicatus Sahlberg
Dendroctonus micans Kugelan
Gilphinia hercyniae (Hartig)
Gonipterus scutellatus Gyll.
Ips amitinus Eichhof
Ips cembrae Heer
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
Popillia japonica Newman
Rhizoecus hibisci Kawai and Takagi

(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 I B

(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

Gremmeniella abietina is one of a number of pests listed in the Appendices to the Terms of Reference to be subject to pest categorisation to determine whether it fulfils the criteria of a quarantine pest or those of a regulated non-quarantine pest (RNQP) for the area of the EU.

Since *G. abietina* is regulated in the protected zones (PZ) only, the scope of the categorisation is the territory of the PZ (Ireland and the UK (Northern Ireland)); thus, the criteria refer to the PZ instead of the EU territory.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search (until June 2017) on *G. abietina* was conducted at the beginning of the categorisation in both the ISI Web of Science and Scopus bibliographic databases, using the scientific name of the pathogen as search term. Further references and information were obtained from experts, from citations within the references and grey literature.

2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from the EPPO Global Database (EPPO, 2017).

Data about import of commodity types that could potentially provide a pathway for the pest to enter the EU and about the distribution of hosts grown in the EU were obtained from EUROSTAT (http://epp.eurostat.ec.europa.eu/newxtweb/) and EUFORGEN (http://www.euforgen.org/), respectively. National forest inventories were also consulted.

Information on EU Member state (MS) imports of *Pinus* plants for planting from North America were sought in the ISEFOR database (Eschen et al., 2017).

The Europhyt database was consulted for pest-specific notifications on interceptions and outbreaks. Europhyt is a web-based network launched by the Directorate General for Health and Consumers (DG SANCO) 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 MS and the phytosanitary measures taken to eradicate or avoid their spread.

2.2. Methodologies

The Panel performed the pest categorisation for *G. abietina*, following guiding principles and steps presented in the EFSA guidance on the harmonised framework for pest risk assessment (EFSA PLH Panel, 2010) and as defined in the International Standard for Phytosanitary Measures No 11 (FAO, 2013) and No 21 (FAO, 2004).

In accordance with the guidance on a harmonised framework for pest risk assessment in the EU (EFSA PLH Panel, 2010), this work was started following an evaluation of the EU's 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 RNQP in accordance with Regulation (EU) 2016/2031 on protective measures against pests of plants and includes additional information required as per 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. Note that a pest that does not qualify as a quarantine pest may still qualify as a RNQP which needs to be addressed in the opinion. For the pests regulated in the PZ only, the scope of the categorisation is the territory of the PZ; thus, the criteria refer to the PZ 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, while addressing social impacts is outside the remit of the Panel, in agreement with the EFSA guidance on a harmonised framework for pest risk assessment (EFSA PLH Panel, 2010).

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? Briefly describe the pest distribution	Is the pest present in the EU territory? If not, it cannot be a PZ quarantine organism	Is the pest present in the EU territory? If not, it cannot be a regulated non-quarantine pest (RNQP). A RNQP 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 RA area, it should be under official control or expected to be under official control in the near future	The PZ 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 PRA 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?

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
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 PZ 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 pest introduction have an economic or environmental impact on the PZ areas?	Does the presence of the pest on plants for planting have an unacceptable 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 EU 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 PZ?	Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria 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 above for consideration as potential PZ quarantine pest were met, and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria 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 state 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, currently the identity of *G. abietina* is well-established, but potential changes in species designation may occur (see the Section 3.1.3 on Intraspecific diversity).

Gremmeniella abietina (Lagerberg) Morelet is a fungus of the family Godroniaceae (Helotiales).

There are many species synonymies: *Ascocalyx abietina, Brunchorstia destruens, Brunchorstia pinea, Brunchorstia pinea* var. *cembrae, Brunchorstia pinea* var. *pinea, Crumenula abietina, Crumenula pinea, Excipulina pinea, Godronia abietina, Gremmeniella abietina* var. *abietina, Gremmeniella abietina* var. *balsamea, Lagerbergia abietina, Pragmopora abietina, Scleroderris abietina, Scleroderris lagerbergii, Septoria pinea* (Index Fungorum, http://www.indexfungorum.org/names/names.asp).

3.1.2. Biology of the pest

G. abietina causes diseases on *Pinus* species and other conifers such as *Abies* spp., *Picea* spp., *Larix* spp. and *Pseudotsuga* spp. known as Scleroderris canker in North America and Brunchorstia dieback in Europe.

During late spring and summer, conidia or ascospores infect the apical buds and developing shoot, generally at the bracts (scales) at the axis of short shoots via the stomata, but direct penetration of the epidermis has also been reported (Sinclair and Lyon, 2005). Wounded needles, buds and shoots are particularly susceptible to infection (EPPO, 1997). Further spread into the shoot does not start until the trees reach dormancy during the winter (Patton et al., 1984). During the winter, the fungus begins to colonise the shoot and cortical tissue. A brown resinous necrotic area beneath the bract is the first symptom of infection. The lesion extends into needle bases and buds and girdles the shoots (Sinclair and Lyon, 2005). The following spring the needles on affected shoots turn reddish brown, fall off and flushing fails. Pycnidia are produced later in the autumn or the following spring, 1 year after symptom development (Hellgren and Barklund, 1992). Black 1 mm pycnidia form in the bark, in cankers or at the needle bases of affected shoots either in clusters or isolated (Sinclair and Lyon, 2005). Conidia are colourless, usually four-celled, 30×3 μm with pointed ends (Sinclair and Lyon, 2005). Most of the conidia have been observed to be dispersed during the spring and summer and coincide with the flush of the current year shoots 2 years after initial infection (Hellgren and Barklund, 1992). Apothecia are found on shoots that have been dead for 1 year, are produced later during the vegetation season and appear to disperse ascospores during a longer time period (Hellgren and Barklund, 1992). Apothecia can also be found concentrated to stem cankers (e.g. on *Pinus contorta*; Witzell, 2001). Apothecia are brown cuplike, 1 mm with short stalks and ascospores are colourless, ellipsoid, four-celled, often slightly curved with rounded ends and $15–22 \times 3–5$ μm (Sinclair and Lyon, 2005).

Sexual reproduction requires at least 2 years (Sinclair and Lyon, 2005), but the fungus can survive in an endophytic stage for an undetermined time period prolonging the cycle (Petrini et al., 1990).

The pathogen also causes canker on branches and stem that are typically recognised as oval 'thumb marks' on young pine bark (Witzell, 2001). Cankers can grow quite fast, especially vertically and extend more than 20 cm (Witzell, 2001).

Rain and high air humidity enhance the release of conidia and ascospores, and are conducive to the establishment of infection. Milder temperatures (-5 to $+5$°C) have been reported to facilitate the infection during the winter, when the dormant host is colonised (Marosy et al., 1989). Large outbreaks of the disease have been associated with long periods of cool, moist weather during the spring and summer (Uotila and Petäistö, 2007; Thomsen, 2009) and to periods of frost (Yokota, 1975; Sairanen, 1990). A long-lasting and deep snow cover has been shown to promote the development of disease in newly established plantations (Karlman et al., 1994).

While conidia are dispersed under wet conditions by a water splash mechanism (Votila, 1985), ascospores may be responsible for long-distance dispersal of the fungus through wind (EPPO, 1997).

Ascospores of the European race (see Section 3.1.3 on Intraspecific diversity) were originally thought to be absent or rare (EPPO, 1997), although this statement was provided without reference. In fact, apothecia were produced abundantly on diseased *Pinus contorta* plantations in northern Sweden (Karlman et al., 1994; Hamelin et al., 1996) and on *Pinus sylvestris* in southern Sweden (Hellgren and Barklund, 1992). The high apothecial production may have been favoured by a long-lasting and deep snow cover (Hamelin et al., 1996).

The survival period of *G. abietina* conidia, European race, has been reported to be over 18 months on *Pinus sylvestris* slash in Sweden (Witzell et al., 2006) and 2 years on *Pinus resinosa* slash in Canada (Laflamme and Rioux, 2015).

3.1.3. Intraspecific diversity

The species *G. abietina* includes several varieties, races and biotypes that are found in different geographical locations, on different hosts and that vary in aggressiveness (Hamelin et al., 2000; Sinclair and Lyon, 2005). Two different varieties of the pathogen have been described:

1) *G. abietina* var. *abietina* found mainly on *Pinus* spp. and *Picea* spp. in North America, Europe and Asia, and
2) *G. abietina* var. *balsamea* which is found mainly in *Abies balsamea* and *Picea* spp. in Canada (Petrini et al., 1989).

Within the former, three different races have been distinguished on geographical, ecological and molecular criteria (Hamelin et al., 1996, 2000; Anon, 2009): the North American, European and Asian races. The North American race mainly infects *Pinus* spp. The Asian race has mainly been found infecting *Abies sachalinensis* in Japan (Yokota et al., 1974). The European race mainly infects *Pinus* spp. but can also infect other conifers. Three different biotypes can be further distinguished within the European race:

1) The Scandinavian biotype, also referred to as the small tree type (STT), northern or B type, is mainly found infecting *Pinus sylvestris*, *Pinus contorta* and *Picea abies* at high altitudes in Northern Europe (Uotila, 1983; Hellgren and Högberg, 1995; Hamelin et al., 1996).
2) The Alpine biotype is found on *Pinus cembra, Pinus mugo, Pinus sylvestris* and *Larix lyallii* at high altitudes in the European Alps (Hamelin et al., 1996).
3) The third biotype within the European race, known as the large tree type (LTT) or A type, is widespread in Europe (Hamelin et al., 1996). This biotype was introduced to North America, assumed to be on infected seedlings during 1950–1960 (See: Hamelin et al., 2000). The genetic difference between the LTT biotype found in Europe and in North America could be due to a founder effect with introduction (Hamelin et al., 1998).

It has been suggested that the different races should be regarded as different species (Hantula and Müller, 1997; Dusabenyagasani et al., 2002; Laflamme, 2010). In addition, some of the biotypes within the European race, i.e. the Scandinavian and the European biotypes do not cross readily in the field (Uotila et al., 2000; Hantula and Tuomivirta, 2003), although they may generate low-fitness hybrids when paired artificially (Hantula and Tuomivirta, 2003). There are also studies indicating that there is limited gene flow between subgroups within the European A type where isolates from North America, Iceland and Italy have been found to be different from isolates originating from Scandinavia and Finland (Hantula and Müller, 1997) and where Spanish isolates were found to be different from Finnish and Russian isolates (Botella et al., 2010). The latter has also been suggested to be a fourth biotype within the European race (Santamaria et al., 2005).

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?	**Yes**

G. abietina can be identified based on the species morphological structures following the EPPO diagnostic protocol PM 7/92(1): *Gremmeniella abietina* (Anon, 2009). There are also molecular methods available to identify the species in infected material or isolated in culture (Hellgren and Högberg, 1995; Hamelin et al., 1996, 1998, 2000; Hantula and Müller, 1997; Zeng et al., 2005; Børja et al., 2006).

The different varieties, races and biotypes of *G. abietina* can be identified and separated based on DNA methods (Hellgren and Högberg, 1995; Hamelin et al., 1996, 1998, 2000; Hantula and Müller, 1997; Zeng et al., 2005; Børja et al., 2006) and by some other methods reviewed in Appendix 1 of the EPPO diagnostic protocol PM 7/92(1): *Gremmeniella abietina* (Anon, 2009).

3.2. Pest distribution

G. abietina is reported from North America, Europe and Asia (EPPO Global Database) (Figure 1).

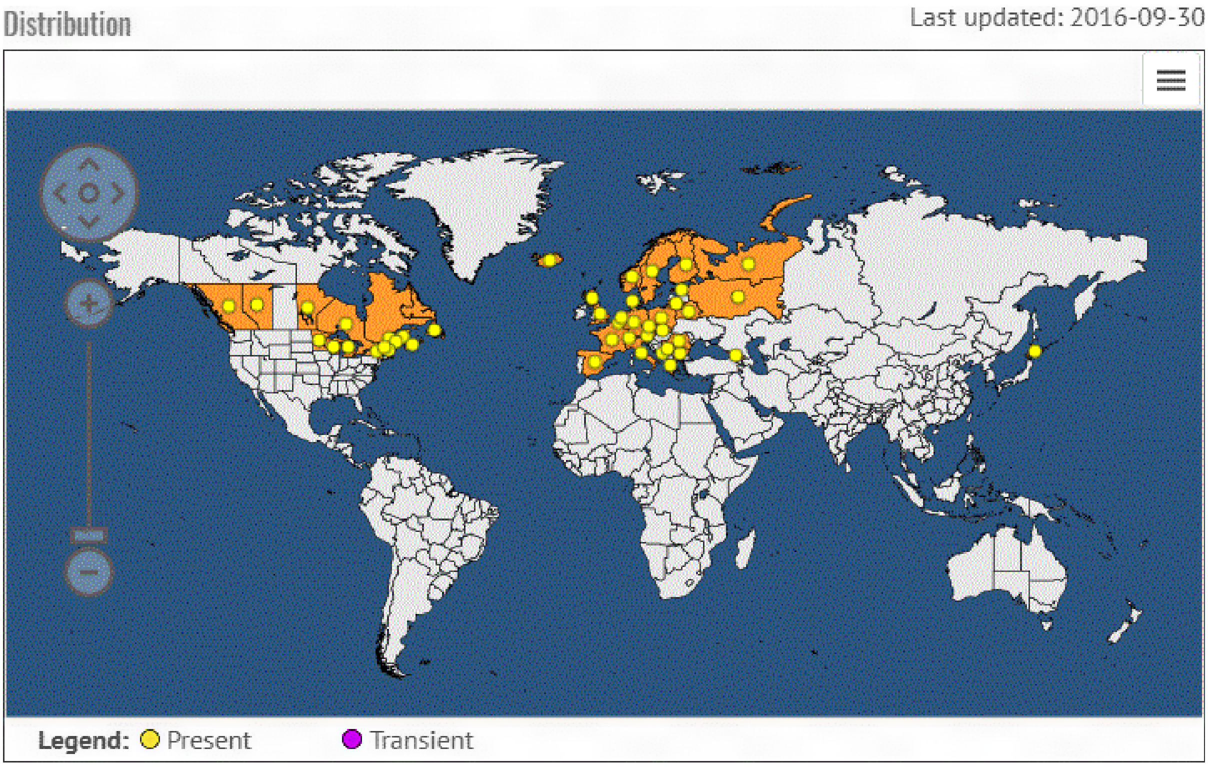

Figure 1: Global distribution map for *Gremmeniella abietina* (extracted from the EPPO Global Database, accessed June 2017). There are no records of transient populations for this species

3.2.1. Pest distribution outside the EU

In North America, the pathogen is found in large parts of Canada (Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland, Nova Scotia, Ontario and Quebec) and in north-eastern states of USA (Maine, Michigan, Minnesota, New Hampshire, New York, Vermont, Wisconsin) (EPPO, 2017).

In Asia, the pathogen has been reported from Japan (EPPO, 2017) and Korea (La et al., 2007).

In non-EU Europe, the fungus has been reported from Belarus, Georgia, Iceland, Montenegro, Norway, Russia, Serbia and Switzerland (EPPO, 2017).

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, *G. abietina* is widely distributed in the EU (but it has not been reported from the PZ).

G. abietina is present in the EU and has been reported from 19 EU MS (Table 2). These countries range from the Mediterranean (Italy and Spain) to the Scandinavian (Finland and Sweden) parts of Europe. Within countries, the reported distribution varies from 'restricted' to 'widespread'.

The pathogen is listed as 'Absent, confirmed by survey' in both Ireland (information from NPPO, 1993; EPPO Global Database) and in the United Kingdom, Northern Ireland (official survey in 2009; EPPO Global Database), which are the countries for which the PZ status applies according to Council Directive 2000/29/EC (Table 3).

There is some uncertainty on the distribution of *G. abietina* in the EU, both for MS having reported it (it is uncertain how widespread the pathogen is there) and for the PZ (it is uncertain whether the pathogen is really absent there). Results on PZ annual surveys which report negative findings are not available to the Panel.

Table 2: Current distribution of *Gremmeniella abietina* in the 28 EU MS based on information from the EPPO Global Database. No other sources of information were used

Country	EPPO Global Database Last update: 30/9/2016 Date accessed: 8/6/2017
Austria	Present, no details
Belgium	Present, no details
Bulgaria	Present, widespread
Croatia	–
Cyprus	–
Czech Republic	Present, restricted distribution
Denmark	Present, widespread
Estonia	Present, no details
Finland	Present, widespread
France	Present, restricted distribution
Germany	Present, restricted distribution
Greece	Present, no details
Hungary	–
Ireland	Absent, confirmed by survey
Italy	Present, restricted distribution
Latvia	–
Lithuania	Present, no details
Luxembourg	–
Malta	–
Poland	Present, restricted distribution
Portugal	–
Romania	Present, no details
Slovak Republic	Present, widespread
Slovenia	–
Spain	Present, restricted distribution
Sweden	Present, widespread
The Netherlands	Present, no details
United Kingdom	Present, restricted distribution in England and Scotland Absent, confirmed by survey in Northern Ireland

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

G. abietina is listed in Council Directive 2000/29/EC. Details are presented in Tables 3 and 4.

Table 3: *G. abietina* in Council Directive 2000/29/EC

Annex II, Part B	**Harmful organisms whose introduction into, and whose spread within, certain protected zones shall be banned if they are present on certain plants or plant products**		
(c)	Fungi		
	Species	Subject of contamination	Protected Zones
2.	*Gremmeniella abietina (Lag.) Morelet*	Plants of *Abies* Mill., *Larix* Mill., *Picea* A. Dietr., *Pinus* L. and *Pseudotsuga* Carr., intended for planting, other than seeds	IRL, UK (Northern Ireland)

3.3.2. Legislation addressing plants and plant parts on which *G. abietina* is regulated

Table 4: Regulated hosts and commodities that may involve *G. abietina* in Annexes III and V of Council Directive 2000/29/EC

Annex III, Part A	Plants, plant products and other objects the introduction of which shall be prohibited in all Member States	
	Description	Country of origin
1.	Plants of *Abies* Mill., *Cedrus* Trew, *Chamaecyparis* Spach, *Juniperus* L., *Larix* Mill., *Picea* A. Dietr., *Pinus* L., *Pseudotsuga* Carr. and *Tsuga* Carr., other than fruit and seeds	Non-European countries
Annex IV, Part B	Special requirements which shall be laid down by all member states for the introduction and movement of plants, plant products and other objects into and within certain protected zones	
Section II	Plants, plant products and other objects originating in the community	
	Plants, plant products and other objects	Special requirements
6.	Plants of *Pinus* L., *Picea* A. Dietr., *Larix* Mill., *Abies* Mill. and *Pseudotsuga* Carr., intended for planting, other than seeds	Without prejudice to the provisions applicable to the plants listed in Annex III(A)(1), Annex IV(A)(I)(8.1), (8.2), (9), Annex IV(A)(II)(4) and Annex IV(B)(7), (8), (9), (10), (11), (12), (13), (15), where appropriate, official statement that the plants have been produced in nurseries and that the place of production is free from *Gremmeniella abietina* (Lag.) Morelet Protected Zones: IRL, UK (Northern Ireland)

Annex V	Plants, plant products and other objects which must be subject to a plant health inspection (at the place of production if originating in the Community, before being moved within the Community—in the country of origin or the consignor country, if originating outside the Community) before being permitted to enter the Community
Part A	Plants, plant products and other objects originating in the Community
Section II	Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for certain protected zones, and which must be accompanied by a plant passport valid for the appropriate zone when introduced into or moved within that zone
1.1.	Plants of *Abies* Mill., *Larix* Mill., *Picea* A. Dietr., *Pinus* L. and *Pseudotsuga* Carr.

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

G. abietina infects various conifer species belonging to the following genera: *Pinus*, *Abies*, *Picea, Larix* and *Pseudotsuga*.

The main hosts reported are *Pinus sylvestris*, *Pinus contorta*, *Abies sachalinensis* and *Picea abies* (CABI, 2015).

However, the following hosts have also been reported: *Larix leptolepis, Picea glauca, Picea rubens, Pinus mariana, Pinus banksiana, Pinus cembra, Pinus densiflora, Pinus flexilis, Pinus griffithii, Pinus monticola, Pinus mugo, Pinus nigra* var. *austriaca, Pinus nigra* var. *corsicana, Pinus nigra* var. *maritima, Pinus pinaster, Pinus pinea, Pinus ponderosa, Pinus radiata, Pinus resinosa, Pinus rigida, Pinus sabiniana, Pinus strobus, Pinus thunbergii, Pinus wallichiana, Pseudotsuga menziesii* (EPPO, 1997) and *Pinus halepensis* (Botella et al., 2010).

The above-named hosts are regulated. However, *Cedrus libani* (on which *G. abietina* is not regulated) has recently been reported to be a host of *G. abietina* on the basis of field inoculations (Doğmuş-Lehtijärvi et al., 2012, 2016).

3.4.2. Entry

Is the pest able to enter into the Protected Zone areas of the EU territory?
Yes, the pest has been reported from 19 EU MS and could enter the EU PZ.

G. abietina is already present in the EU and the European race is believed to originate from Europe.

The main pathways of entry into the PZ are:

- Plants for planting are considered to be a host commodity providing a pathway for entry (EPPO, 2017). For plants for planting of *Abies, Larix, Picea, Pinus* and *Pseudotsuga* spp. produced in the EU and moved to the PZ, there must be an official statement that the plants have been produced in nurseries and that the place of production is free from *G. abietina* (Annex IV B).
- Christmas trees of *Pinus sylvestris* were shown to harbour the pathogen and potentially provide a means of transport (Magasi and Manley, 1974).
- Natural spread from other EU MS (see Section 3.4.4 on Spread).

In the ISEFOR database of plants for planting (Eschen et al., 2017), there are no records of *Pinus* plants for planting imported by the PZ (Ireland and Northern Ireland) from the countries (both within and outside the EU) with reports of *G. abietina.*

In principle, wood with bark could provide a pathway of entry (but see Section 3.4.4).

According to EUROSTAT, between 2011 and 2015, about 130 tonnes of *Pinus* spp. wood in the rough were imported into the EU from the USA and Canada.

As of May 2017, there are no records of interception of *G. abietina* in the Europhyt database.

3.4.3. Establishment

Is the pest able to become established in the Protected Zone areas of the EU territory?
Yes, the pest is already established in 19 EU MS, some of which have a climate similar to the one found in the PZ (Ireland and Northern Ireland).

3.4.3.1. EU distribution of main host plants

G. abietina is already established in most of the EU territory (see Table 2). The two main European host species *Pinus sylvestris* and *Picea abies* are widely distributed in central and northern Europe (Figures 2 and 3). The former species is also present, although with a more fragmented distribution, in Scotland, in southern France, in the Iberian and Balkan Peninsulas. The latter species is present in central Europe mostly in mountain areas. Also as genera, *Pinus* and *Picea* are widely present in EU forests (Figures 4a and 5a). The trustability in relation to the probability of the presence (see Appendix A) of both genera is low in the PZ (Figures 4b and 5b).

However, while the natural distribution areas of the main host species do not extend into the PZ (Ireland and Northern Ireland), based on the Irish National Forest Inventory (2007) *P. sylvestris* and *P. abies* have been frequently planted in the Republic of Ireland, with 0.5% and 2.8% of the total number of trees, respectively. Among the exotic host species, *P. contorta* has been widely planted in Ireland, representing about 10% of the total stocked forest area (National Forest Inventory of the Republic of Ireland, 2007).

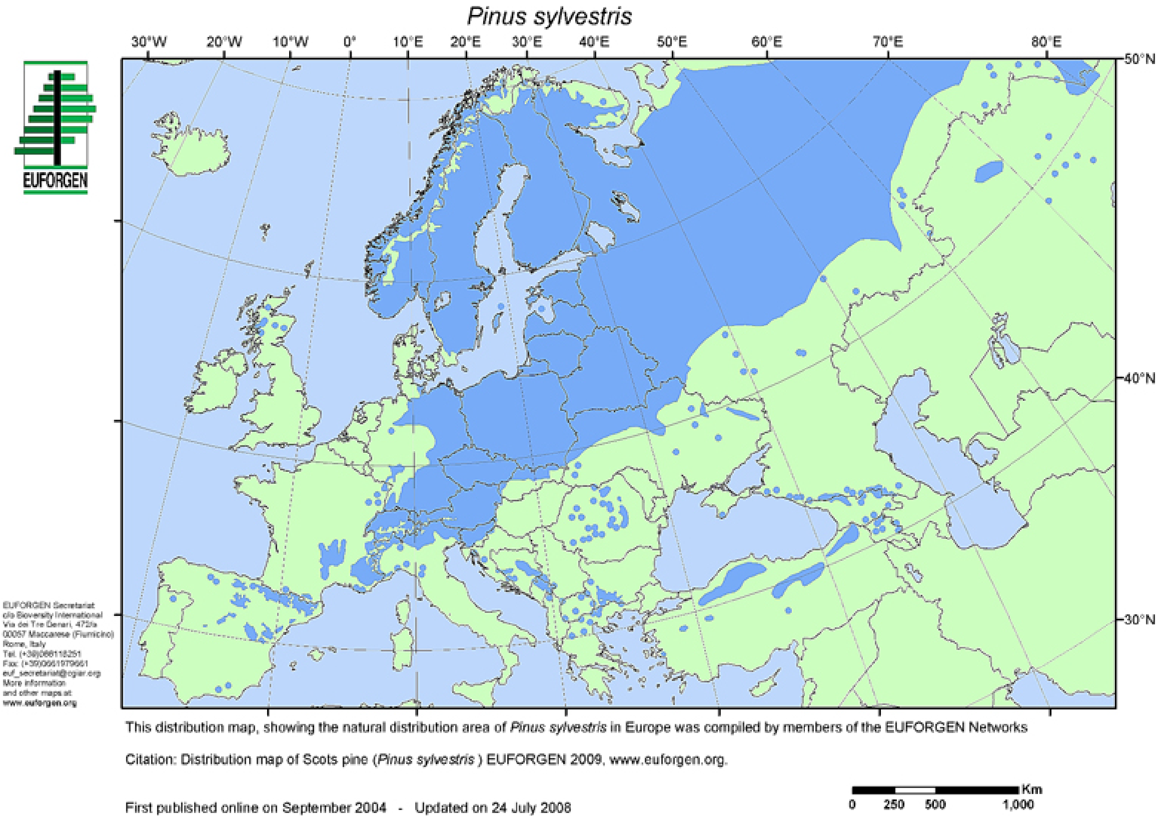

Figure 2: Native range of *Pinus sylvestris* in Europe (map prepared by Euforgen in 2009). Blue dots represent isolated occurrences of the species

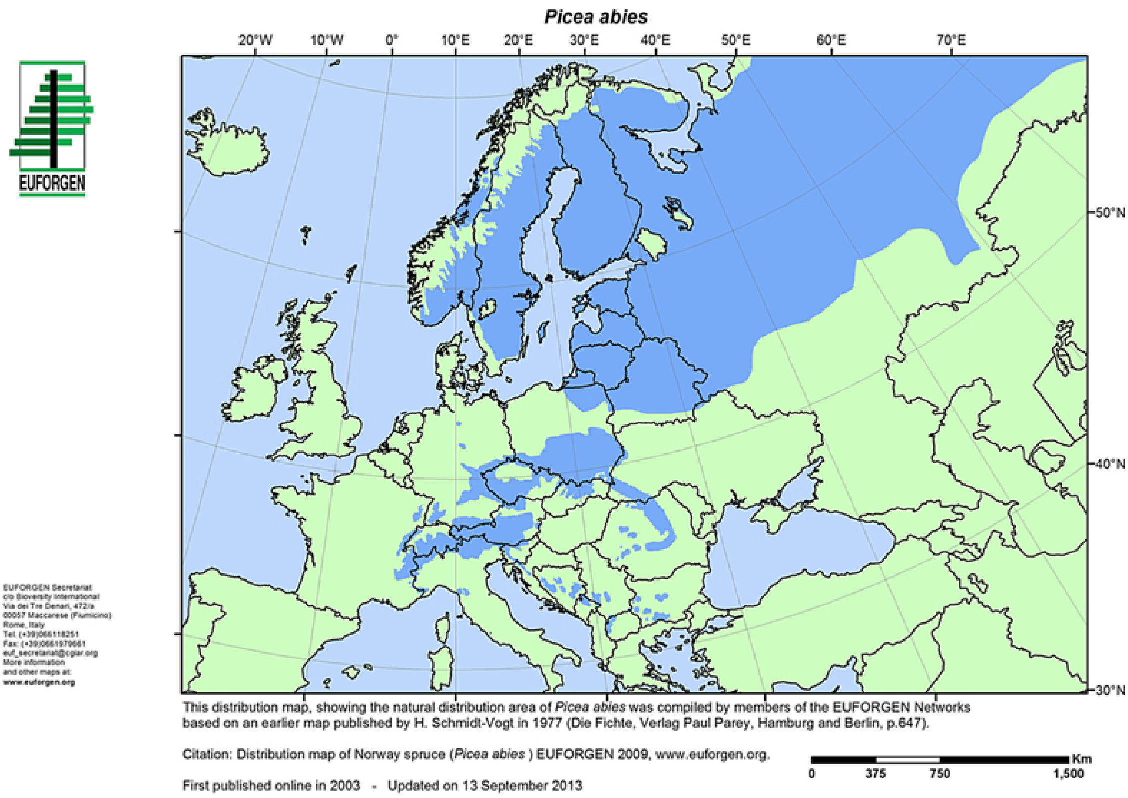

Figure 3: Native range of *Picea abies* in Europe (map prepared by Euforgen in 2009)

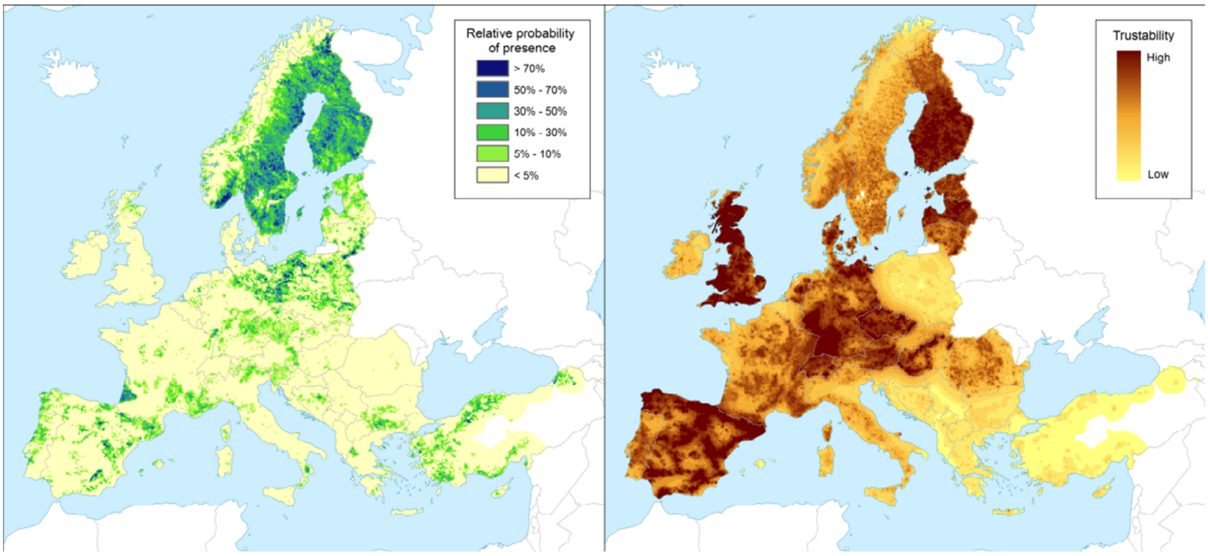

Figure 4: Left-hand panel: Relative probability of presence (RPP) of the genus *Pinus* (based on data from the species: *P. sylvestris, P. pinaster, P. halepensis, P. nigra, P. pinea, P. contorta, P. cembra, P. mugo, P. radiata, P. canariensis, P. strobus, P. brutia, P. banksiana, P. ponderosa, P. heldreichii, P. leucodermis, P. wallichiana*) in Europe, mapped at 100 km^2 resolution. The underlying data are from European-wide forest monitoring data sets and from national forestry inventories based on standard observation plots measuring in the order of hundreds m^2. RPP represents the probability of finding at least one individual of the taxon in a standard plot placed randomly within the grid cell. For details, see Appendix A (courtesy of JRC, 2017). Right-hand panel: Trustability of RPP. This metric expresses the strength of the underlying information in each grid cell and varies according to the spatial variability in the forestry inventories). The colour scale of the trustability map is obtained by plotting the cumulative probabilities (0–1) of the underlying index (for details see Appendix A)

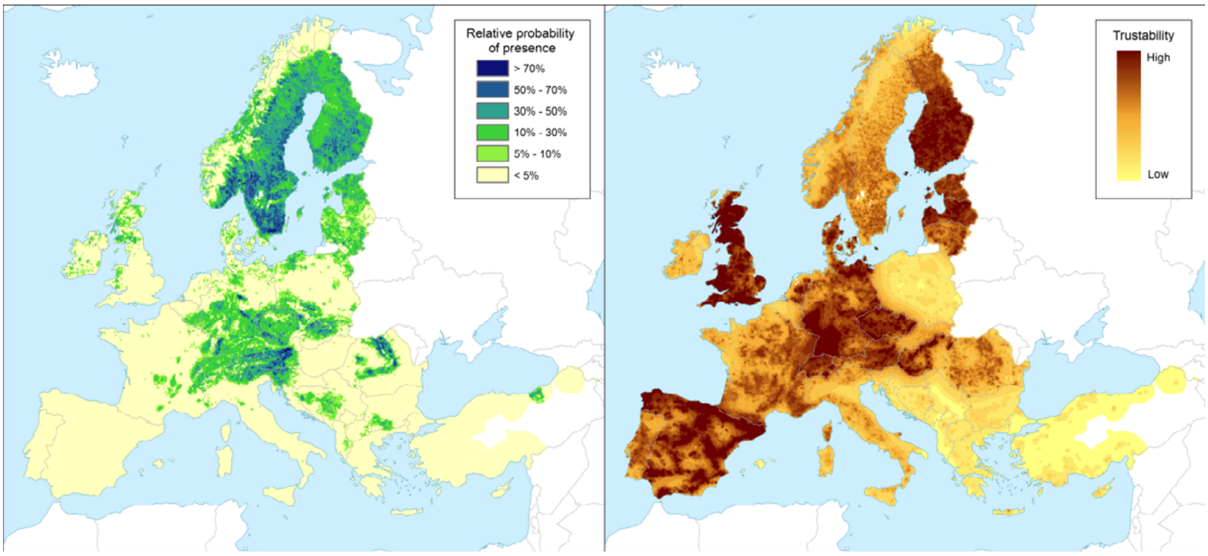

Figure 5: Left-hand panel: Relative probability of presence (RPP) of the genus *Picea* (based on data from the species: *P. abies, P. sitchensis, P. glauca, P. engelmannii, P. pungens, P. omorika, P. orientalis, P. leucodermis*) in Europe, mapped at 100 km^2 resolution. The underlying data are from European-wide forest monitoring data sets and from national forestry inventories based on standard observation plots measuring in the order of hundreds m^2. RPP represents the probability of finding at least one individual of the taxon in a standard plot placed randomly within the grid cell. For details, see Appendix A (courtesy of JRC, 2017). Right-hand panel: Trustability of RPP. This metric expresses the strength of the underlying information in each grid cell and varies according to the spatial variability in forestry inventories. The colour scale of the trustability map is obtained by plotting the cumulative probabilities (0–1) of the underlying index (for details see Appendix A)

3.4.3.2. Climatic conditions affecting establishment

Given that *G. abietina* has been reported from EU regions with a wide variety of climatic and ecological conditions (e.g. from Greece to Lithuania and from Scotland to Spain), there are no obvious ecoclimatic factors limiting its establishment. The climatic conditions that are most conducive for establishment and outbreak are long periods of cool, moist weather during the spring and summer (Uotila and Petäistö, 2007; Thomsen, 2009). These conditions are likely to frequently occur in Ireland and Northern Ireland.

3.4.4. Spread

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

Yes, via conidia mostly disseminated through rain splash, wind-dispersed ascospores, and through infected plants for planting.

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 only one of the means of spread.

In natural conditions, the spread of the pathogen may occur by means of both ascospores and conidia. It was previously thought that the European race of *G. abietina* var. *abietina* mostly disperses through rain-splashed conidia (EPPO, 1997). However, dispersal by means of airborne ascospores is known to occur, which may have implications for the spread of the disease (Section 3.1.2). If conidia are involved, infection usually occurs in early summer, whereas ascospores infect later during the growing period and late in autumn (Skilling, 1972; Gibbs, 1984; Laflamme and Archambault, 1990; Hellgren and Barklund, 1992).

The pathogen can also spread through the movement of infected plants for planting and Christmas trees. As the fungus can survive in an endophytic stage for an undetermined period of time (Petrini et al., 1990), it can be moved over long distances in infected but asymptomatic plants (Hamelin et al., 1998).

In the ISEFOR database of plants for planting, there are no records of *Pinus* plants for planting imported by the PZ (Ireland and Northern Ireland) from the countries (both within and outside the EU) with reports of *G. abietina.*

The opportunity for dispersal through movement of infected wood is limited because: first, most fruiting bodies are produced on shoots and branches which are left on the ground when harvesting; second, if there are fruiting bodies on the trunk (an infrequent occurrence), because of their small size, young infected trees are not commercialised; or for bigger trees, the cankers will make the logs unsuitable for harvesting and be classified as waste or at least as portions with defects (Gaston Laflamme, Canadian Forest Service, personal communication, 19 June 2017). It is uncertain whether use of such waste as wood chips in landscaping could contribute to the dispersal of the pathogen.

3.5. Impacts

Would the pest introduction have an economic or environmental impact on the Protected Zones of the EU?

Yes. Given that *G. abietina* is most damaging to species that are grown towards the limit of their range, and given that the EU PZ are outside of the native range of the main hosts of the pathogen, impact can be expected in the PZ, should the pathogen be introduced.

Outside of the EU, *G. abietina* is present in North America and Asia, where the main hosts are *Pinus contorta* and *Abies sachalinensis*, respectively. In that context, the disease may kill young trees as well as reduce growth and cause distortion of older trees. It can also cause serious nursery losses. Under severe conditions, all the foliage of the host may be affected and die (Figure 6). Severe outbreaks have been reported in Quebec, where the pathogen was found in 163 plantations, primarily on *Pinus resinosa* and occasionally on *Pinus sylvestris*, during a survey of more than 1,000 pine plantations (Laflamme and Lachance, 1987).

Figure 6: Damage due to *Gremmeniella abietina* on *Pinus resinosa* in the USA, with kind permission of USDA Forest Service, North Central Research Station (available online at https://www.invasive.org/browse/detail.cfm?imgnum=1406101)

G. abietina is present in Europe, where the main hosts are *Pinus sylvestris* and *Picea abies*. However, destructive epidemics have also been reported on other pine species, including some exotic pines (e.g. the North American *Pinus contorta*). In general, the pathogen is most damaging to species that are grown towards the limit of their range (CABI, 2015).

While the disease is characterised by death of the growing point and the apical needles, under severe conditions, the pathogen can kill the trees. In Sweden, an epidemic starting in 2001 covered more than 450,000 ha of mainly 30- to 50-year-old and some 70- to 80-year-old *Pinus sylvestris* stands (Wulff et al., 2006). About 50,000 ha were sanitarily thinned or clear cut (Wulff et al., 2006). That epidemic seriously influenced the forest industry regionally. The net losses due to the disease were estimated to reach 250 million Euro (Hansson et al., 2004). Concerning this epidemic, recent analyses of volume dynamics in some stands indicated a decade-long negative effect of pathogen infections (Wang et al., 2017). Over the years 2000–2012, the difference between projected (assuming no infection) and observed volume growth ranged between 10% and 62%. Height growth of *Pinus sylvestris* in affected stands was reduced by 64–85%. The average reduction in basal area increment in affected areas countrywide, accumulated over 2000–2006, was about 21% for *Pinus sylvestris* and 4% for *Picea abies* (Wang et al., 2017).

In Finland, volume growth in moderately infested *Pinus sylvestris* stands decreased by 22–42%, depending on disease severity (Riihinen and Uotila, 1992).

In a study in the Swiss Alps, a total of about 60% of *Pinus cembra* and about 45% of *Pinus mugo* trees were killed by *G. abietina* during the first 20 years after planting in subalpine stands (Senn, 1999). In another study performed in Switzerland, only 5% of all *Pinus cembra* trees survived to *G. abietina* and *Phacidium infestans* attacks 30 years after planting in two sites at the tree line (Barbeito et al., 2013).

In Sweden, *Pinus contorta* logs with occluded cankers caused by *G. abietina* gave pulp with poor paper properties (Ahlqvist et al., 1996). Thus, wood damaged by *G. abietina* should be separated and classed as low-grade raw material.

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 Protected Zones such that the risk becomes mitigated?

Yes. Please see section 3.6.3.

Is it possible to eradicate the pest in a restricted area within 24 months after the presence of the pest was confirmed in the PZ?

No. There is no evidence that eradication can be achieved.

Hudler and Neal (1990) demonstrated that postharvest treatments (hot water treatment and sodium hypochlorite treatment) led to complete eradication of the pathogen from seedlings.

Bernhold et al. (2006) found that slash removal and piling of infected material were not enough to eradicate infection sources and concluded that burning or complete removal of slash would be needed to reduce inoculum sources further.

Once established in a plantation, the impossibility of control has been stated (EPPO, 1997), although the evidence used in support of this statement is not provided.

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

The pathogen can survive in an endophytic stage for an undetermined period of time (Petrini et al., 1990). Therefore, despite the uncertainty, it might be moved over long distances in infected but asymptomatic plants.

3.6.2. Biological or technical factors limiting the ability to prevent the presence of the pest on plants for planting

- The indeterminate endophytic phase (see above) hinders the ability to promptly identify the presence of the pest on the source material.
- The widespread distribution of the pathogen may lead to infection from conidia or ascospores entering the nursery site of production from surrounding areas.
- Chemical control in nurseries may mask the symptoms, thus resulting in infected asymptomatic plants for planting carrying the pathogen over long distances.

3.6.3. Control methods

- Selection of disease-free planting material.
- Selection of planting sites at some distance from infested plantations.
- Selection of sites suitable for the grown tree species, so as to avoid stress (Nevalainen, 1999; Witzell and Karlman, 2000).

- Growing plants for planting in sites characterised by climatic conditions unsuitable or non-conducive for dissemination and infection (e.g. sites not characterised by cool and wet springs and/or by risk of frost damages).
- Selection of host provenances with low susceptibility to the pathogen and suitable for the sites and regions where they are grown (Hansson, 1998; Romeralo et al., 2016).
- As attacks are favoured by shaded conditions, by dense, badly aerated plantations in which humidity is high, appropriate spacing between plants and thinnings may reduce the risk of infection.
- Pruning of the lower half of the crown whorls is recommended in infected plantations less than 20 years old (CABI, 2015 based on Laflamme, 1999).
- Delaying pine plantation until after two growing seasons following harvesting of diseased pine trees is recommended (Laflamme and Rioux, 2015).
- Slash burning or complete removal of the infected slash is needed to minimise the infection risk (Bernhold et al., 2006).
- Treatment with fungicides at the nursery stage (for instance with chlorothalonil, propiconazole and azoxystrobin) applied from May to mid-August (Nef and Perrin, 1999; CABI, 2015).

3.7. Uncertainty

There is uncertainty on the outcome of revising the taxonomic status of the species, given its current intraspecific diversity.

There is some uncertainty on the distribution of *G. abietina* in the EU, both for MS having reported it (it is uncertain how widespread the pathogen is there) and for the PZ (it is uncertain whether the pathogen is really absent there). Results on PZ annual surveys which report negative findings are not available to the Panel.

There is uncertainty over the host status of hosts not currently regulated, e.g. *Cedrus libani*.

There is considerable uncertainty on the length of the endophytic stage of the pathogen in host plants, which makes it difficult to reduce the presence of the pest on plants for planting.

It is also unclear whether infected wood with bark could be an effective means of spread of the pathogen, whether disposal of infected rootless Christmas trees could carry the pathogen and whether wood products such as wood chips could provide a means of spread.

4. Conclusions

G. abietina meets the criteria assessed by EFSA for consideration as a potential PZ quarantine pest for the territory of the PZ (Ireland and Northern Ireland) (Table 5).

Table 5: 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)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	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 pest as a species is clear	The identity of the pest as a species is clear	The species *G. abietina* includes several varieties, races and biotypes that are found in different geographical locations, on different hosts and that vary in aggressiveness. This could lead to a revision of the identity of the pest in the future

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Absence/ presence of the pest in the EU territory (Section 3.2)	*G. abietina* is present in the EU and has been reported from 19 MS The pathogen is listed as 'Absent, confirmed by survey' in both PZ (Ireland and in Northern Ireland)	*G. abietina* is present in the EU and has been reported from 19 MS The pathogen is listed as 'Absent, confirmed by survey' in both PZ (Ireland and in Northern Ireland)	There is some uncertainty on the distribution of *G. abietina* in the EU, including the PZ. This is because the official reports documenting absence go back to 1993 and 2009
Regulatory status (Section 3.3)	*G. abietina* is regulated by Council Directive 2000/29/EC on plants of *Abies*, *Larix*, *Picea*, *Pinus* and *Pseudotsuga*, intended for planting, other than seeds, for Protected Zones (Annex II, Part B) (Ireland and the UK (Northern Ireland)	*G. abietina* is regulated by Council Directive 2000/29/EC on plants of *Abies*, *Larix*, *Picea*, *Pinus* and *Pseudotsuga*, intended for planting, other than seeds, for Protected Zones (Annex II, Part B) (Ireland and the UK (Northern Ireland)	None
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Entry: the pest has been reported from 19 EU MS and could enter the EU PZ Establishment: the pest is already established in 19 EU MS, some of which (e.g. the UK) have a climate similar to the one found in the PZ (Ireland and Northern Ireland) Spread: the pest would be able to spread within the PZ of the EU following establishment, via airborne ascospores, rain-splashed conidia, infected plants for planting, Christmas trees and, possibly, wood with bark	The pathogen can be spread by plants for planting, but also via airborne ascospores and rain-splashed conidia	There is uncertainty over: the host status of hosts not currently regulated, e.g. *Cedrus libani* whether infected wood with bark could be an effective means of spread of the pathogen whether disposal of infected rootless Christmas trees could carry the pathogen and whether wood products such as wood chips could provide a means of spread
Potential for consequences in the EU territory (Section 3.5)	Given that *G. abietina* is most damaging to species that are grown towards the limit of their range, and given that the PZ are outside of the native range of the main hosts of the pathogen (*Picea abies* and *Pinus sylvestris*), which are nonetheless planted in the PZ, impact can be expected in the PZ, if the pathogen is introduced there	*G. abietina* could be of economic importance on the use of plants for planting in the EU MS where it is reported because of the requirement for nurseries producing for the PZ to be certified as pest-free	Differential responses of the different hosts to the different biotypes of *G. abietina*

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Available measures (Section 3.6)	Selection of disease-free planting material, selection of planting sites at some distance from infested plantations, appropriate spacing between plants and thinning may reduce the risk of infection There is no evidence that eradication of the pathogen in a restricted area can be achieved	Nursery inspections to ensure plantations or landscape plantings are not made with infected stock Growing plants for planting in sites characterised by climatic conditions unsuitable or non-conducive for dissemination and infection Treatment with fungicides at the nursery stage	The indeterminate endophytic stage makes the effectiveness of the available measures uncertain
Conclusion on pest categorisation (Section 4)	The criteria assessed by the Panel for consideration as potential PZ quarantine pest are met	The criterion on plants for planting as main pathway for spread is not met, as plants for planting are only one of the means of spread of the pathogen	
Aspects of assessment to focus on/ scenarios to address in future if appropriate	Intraspecific variation and distribution of the different biotypes, with regard to the potential introduction of the North American and/or Asian race and the movement of biotypes of the European race within the EU		

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Abbreviations

CLC	Corine Land Cover
EPPO	European and Mediterranean Plant Protection Organization
EU MS	European Union Member State
EUFGIS	European Information System on Forest Genetic Resources
FAO	Food and Agriculture Organization
GD^2	Georeferenced Data on Genetic Diversity
IPPC	International Plant Protection Convention
JRC	Joint Research Centre of the European Commission
LTT	large tree type
PLH	EFSA Panel on Plant Health
PZ	protected zone
RA	risk assessment
RNQP	regulated non-quarantine pest
RPP	relative probability of presence
RRO	risk reduction option
SMFA	spatial multiscale frequency analysis
STT	small tree type

Appendix A – Methodological notes on Figures 4 and 5

The relative probability of presence (RPP) reported here for *Pinus* spp. and *Picea* spp. in Figures 4 and 5 and in the European Atlas of Forest Tree Species (De Rigo et al., 2016; San-Miguel-Ayanz et al., 2016) is the probability of those genera to occur in a given spatial unit (de Rigo et al., 2017). In forestry, such a probability for a single taxon is called "relative". The maps of RPP are produced by spatial multiscale frequency analysis (C-SMFA) (de Rigo et al., 2017) of species presence data reported in geolocated plots by different forest inventories (de Rigo et al., 2014).

A.1. Geolocated plot databases

The RPP models rely on five geodatabases that provide presence/absence data for tree species and genera (de Rigo et al., 2014, 2016, 2017). The databases report observations made inside geolocalised sample plots positioned in a forested area but do not provide information about the plot size or consistent quantitative information about the recorded species beyond presence/absence.

The harmonisation of these data sets was performed as activity within the research project at the origin of the European Atlas of Forest Tree Species (De Rigo et al., 2016; San-Miguel-Ayanz, 2016; San-Miguel-Ayanz et al., 2016). Given the heterogeneity of strategies of field sampling design and establishment of sampling plots in the various national forest inventories (Chirici et al. 2011a,b), and also given legal constraints, the information from the original data sources was harmonised to refer to an INSPIRE compliant geospatial grid, with a spatial resolution of 1 km^2 pixel size, using the ETRS89 Lambert Azimuthal Equal-Area as geospatial projection (EPSG: 3035, http://spatialreference.org/ref/epsg/etrs89-etrs-laea/).

A.1.1. European National Forestry Inventories database

This data set was derived from National Forest Inventory data and provides information on the presence/absence of forest tree species in ~ 375,000 sample points with a spatial resolution of 1 km^2/pixel, covering 21 European countries (de Rigo et al., 2014, 2016, 2017).

A.1.2. Forest Focus/Monitoring data set

This project is a Community scheme for harmonised long-term monitoring of air pollution effects in European forest ecosystems, normed by EC Regulation No 2152/2003[4]. Under this scheme, the monitoring is carried out by participating countries on the basis of a systematic network of observation points (Level I) and a network of observation plots for intensive and continuous monitoring (Level II). For managing the data, the JRC implemented a Forest Focus Monitoring Database System, from which the data used in this project were taken (Hiederer et al., 2007; Houston Durrant and Hiederer, 2009). The complete Forest Focus data set covers 30 European Countries with more than 8,600 sample points.

A.1.3. BioSoil data set

This data set was produced by one of a number of demonstration studies initiated in response to the 'Forest Focus' Regulation (EC) No 2152/2003 mentioned above. The aim of the BioSoil project was to provide harmonised soil and forest biodiversity data. It comprised two modules: a Soil Module (Hiederer et al., 2011) and a Biodiversity Module (Houston Durrant et al., 2011). The data set used in the C-SMFA RPP model came from the Biodiversity module, in which plant species from both the tree layer and the ground vegetation layer were recorded for more than 3,300 sample points in 19 European Countries.

A.1.4. European Information System on Forest Genetic Resources (EUFGIS)

EUFGIS (http://portal.eufgis.org) is a smaller geodatabase that provides information on tree species composition in over 3,200 forest plots in 34 European countries. The plots are part of a network of forest stands managed for the genetic conservation of one or more target tree species. Hence, the plots represent the natural environment to which the target tree species are adapted.

[4] Council of the European Union, 2003. Regulation (EC) No 2152/2003 of the European Parliament and of the Council of 17 November 2003 concerning monitoring of forests and environmental interactions in the Community (Forest Focus). Official Journal of the European Union 46 (L 324), 1–8.

A.1.5. Georeferenced Data on Genetic Diversity (GD^2)

GD^2 (http://gd2.pierroton.inra.fr) provides information about 63 species of interest for genetic conservation. The database covers 6,254 forest plots located in stands of natural populations that are traditionally analysed in genetic surveys. While this database covers fewer species than the others, it covers 66 countries in Europe, North Africa and the Middle East, making it the data set with the largest geographic extent.

A.2. Modelling methodology

For modelling, the data were harmonised in order to have the same spatial resolution (1 km^2) and filtered to a study area that comprises 36 countries in the European continent. The density of field observations varies greatly throughout the study area and large areas are poorly covered by the plot databases. A low density of field plots is particularly problematic in heterogeneous landscapes, such as mountainous regions and areas with many different land use and cover types, where a plot in one location is not representative of many nearby locations (de Rigo et al., 2014). To account for the spatial variation in plot density, the model used here (C-SMFA) considers multiple spatial scales when estimating RPP. Furthermore, statistical resampling is systematically applied to mitigate the cumulated data-driven uncertainty.

The presence or absence of a given forest tree species then refers to an idealised standard field sample of negligible size compared with the 1 km^2 pixel size of the harmonised grid. The modelling methodology considered these presence/absence measures as if they were random samples of a binary quantity (the punctual presence/absence, not the pixel one). This binary quantity is a random variable having its own probability distribution which is a function of the unknown average probability of finding the given tree species within a plot of negligible area belonging to the considered 1 km^2 pixel (de Rigo et al., 2014). This unknown statistic is denoted hereinafter with the name of "probability of presence".

C-SMFA performs spatial frequency analysis of the geolocated plot data to create preliminary RPP maps (de Rigo et al., 2014). For each 1 km^2 grid cell, the model estimates kernel densities over a range of kernel sizes to estimate the probability that a given species is present in that cell. The entire array of multiscale spatial kernels is aggregated with adaptive weights based on the local pattern of data density. Thus, in areas where plot data are scarce or inconsistent, the method tends to put weight on larger kernels. Wherever denser local data are available, they are privileged ensuring a more detailed local RPP estimation. Therefore, a smooth multiscale aggregation of the entire arrays of kernels and data sets is applied instead of selecting a local 'best preforming' one and discarding the remaining information. This array-based processing and the entire data harmonisation procedure are made possible thanks to the semantic modularisation which defines the Semantic Array Programming modelling paradigm (de Rigo, 2012).

The probability to find a single species (e.g. a particular coniferous tree species) in a 1 km^2 grid cell cannot be higher than the probability of presence of all the coniferous species combined. The same logical constraints applied to the case of single broadleaved species with respect to the probability of presence of all the broadleaved species combined. Thus, to improve the accuracy of the maps, the preliminary RPP values were constrained so as to not exceed the local forest-type cover fraction with an iterative refinement (de Rigo et al., 2014). The forest-type cover fraction was estimated from the classes of the Corine Land Cover (CLC) maps which contain a component of forest trees (Bossard et al., 2000; Büttner et al., 2012).

The resulting probability of presence is relative to the specific tree taxon, irrespective of the potential co-occurrence of other tree taxa with the measured plots, and should not be confused with the absolute abundance or proportion of each taxon in the plots. RPP represents the probability of finding at least one individual of the taxon in a plot placed randomly within the grid cell, assuming that the plot has negligible area compared with the cell. As a consequence, the sum of the RPP associated with different taxa in the same area is not constrained to be 100%. For example, in a forest with two co-dominant tree species which are homogeneously mixed, the RPP of both may be 100% (see e.g. the Glossary in San-Miguel-Ayanz et al. (2016), http://forest.jrc.ec.europa.eu/media/atlas/Glossary.pdf).

The robustness of RPP maps depends strongly on sample plot density, as areas with few field observations are mapped with greater uncertainty. This uncertainty is shown qualitatively in maps of 'RPP trustability'. RPP trustability is computed on the basis of the aggregated equivalent number of sample plots in each grid cell (equivalent local density of plot data). The trustability map scale is relative, ranging from 0 to 1, as it is based on the quantiles of the local plot density map obtained using all field observations for the species. Thus, trustability maps may vary among species based on the number of databases that report a particular species (de Rigo et al., 2014, 2016, 2017).

The RPP and relative trustability range from 0 to 1 and are mapped at a 1 km spatial resolution. To improve visualisation, these maps can be aggregated to coarser scales (i.e. 10 × 10 pixels or 25 × 25 pixels, respectively, summarising the information for aggregated spatial cells of 100 and 625 km^2) by averaging the values in larger grid cells.