

ADOPTED: 22 March 2018

doi: 10.2903/j.efsa.2018.5246

Pest categorisation of *Mycodiella laricis-leptolepidis*

EFSA Panel on Plant Health (PLH),

Michael Jeger, Claude Bragard, David Caffier, Thierry Candresse, Elisavet Chatzivassiliou, Katharina Dehnen-Schmutz, Gianni Gilioli, Jean-Claude Grégoire, 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 Panel on Plant Health (PLH) performed a pest categorisation of *Mycodiella laricis-leptolepidis*, a well-defined and distinguishable fungal species of the family Mycosphaerellaceae. The former species name *Mycosphaerella laricis-leptolepis* is used in the Council Directive 2000/29/EC. The pathogen is regulated in Annex IAI as a harmful organism whose introduction into the EU is banned. *M. laricis-leptolepidis* is native to East Asia and causes a disease known as needle cast of Japanese larch (*Larix kaempferi* = *Larix leptolepis*) and Kurile larch (*Larix gmelinii*). European larch (*Larix decidua*) was found to be susceptible to the disease as introduced tree in Japan. The fungus could enter the EU via plants for planting and cut branches of *Larix* spp. It could establish in the EU, as hosts are present and climatic conditions are favourable. The pathogen would be able to spread following establishment by human movement of infected plants for planting and by dissemination of ascospores. Should the pathogen be introduced in the EU, impacts can be expected due to needle loss in larch forests and plantations, thus leading to reduced tree growth and ecosystem service provision. The use of resistant/tolerant varieties can reduce the impacts. The key uncertainties are the knowledge gaps concerning (i) the potential range of spread through ascospores and (ii) the level of impacts in the native range of the pathogen. The criteria assessed by the Panel for consideration as a potential quarantine pest are met. For regulated non-quarantine pests, the criterion on the pest presence in the EU is not met.

© 2018 European Food Safety Authority. *EFSA Journal* published by John Wiley and Sons Ltd on behalf of European Food Safety Authority.

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

Requestor: European Commission

Question number: EFSA-Q-2018-00029

Correspondence: alpha@efsa.europa.eu

Panel members: Claude Bragard, David Caffier, Thierry Candresse, Elisavet Chatzivassiliou, Katharina Dehnen-Schmutz, Gianni Gilioli, Jean-Claude Grégoire, 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.

Suggested citation: EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Grégoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Urek G, Van Bruggen A, Van der Werf W, West J, Winter S, Boberg J, Gonthier P and Pautasso M, 2018. Scientific Opinion on the pest categorisation of *Mycodiella laricis-leptolepidis*. EFSA Journal 2018;16(4):5246, 25 pp. <https://doi.org/10.2903/j.efsa.2018.5246>

ISSN: 1831-4732

© 2018 European Food Safety Authority. *EFSA Journal* published by John Wiley and Sons Ltd on behalf of European Food Safety Authority.

This is an open access article under the terms of the [Creative Commons Attribution-NoDerivs](https://creativecommons.org/licenses/by/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited and no modifications or adaptations are made.

Reproduction of the images listed below is prohibited and permission must be sought directly from the copyright holder:

Figure 1: © European and Mediterranean Plant Protection Organization (EPPO); Figures 2, 4–5: © European Union; Figure 3: © EUFORGEN; Figure 6: © Bugwood.org.



The EFSA Journal is a publication of the European Food Safety Authority, an agency of the European Union.



Table of contents

Abstract.....	1
1. Introduction.....	4
1.1. Background and Terms of Reference as provided by the requestor.....	4
1.1.1. Background.....	4
1.1.2. Terms of reference.....	4
1.1.2.1. Terms of Reference: Appendix 1.....	5
1.1.2.2. Terms of Reference: Appendix 2.....	6
1.1.2.3. Terms of Reference: Appendix 3.....	7
1.2. Interpretation of the Terms of Reference.....	8
2. Data and methodologies.....	8
2.1. Data.....	8
2.1.1. Literature search.....	8
2.1.2. Database search.....	8
2.2. Methodologies.....	9
3. Pest categorisation.....	11
3.1. Identity and biology of the pest.....	11
3.1.1. Identity and taxonomy.....	11
3.1.2. Biology of the pest.....	11
3.1.3. Intraspecific diversity.....	11
3.1.4. Detection and identification of the pest 12.....	11
3.2. Pest distribution.....	11
3.2.1. Pest distribution outside the EU.....	12
3.2.2. Pest distribution in the EU.....	12
3.3. Regulatory status.....	12
3.3.1. Council Directive 2000/29/EC.....	12
3.3.2. Legislation addressing the hosts of <i>M. laricis-leptolepidis</i>	13
3.4. Entry, establishment and spread in the EU.....	13
3.4.1. Host range.....	13
3.4.2. Entry.....	13
3.4.3. Establishment.....	14
3.4.3.1. EU distribution of main host plants.....	14
3.4.3.2. Climatic conditions affecting establishment.....	17
3.4.4. Spread.....	17
3.5. Impacts.....	18
3.6. Availability and limits of mitigation measures.....	19
3.6.1. Phytosanitary measures.....	19
3.6.1.1. Biological or technical factors limiting the feasibility and effectiveness of measures to prevent the entry, establishment and spread of the pest.....	19
3.6.1.2. Biological or technical factors limiting the ability to prevent the presence of the pest on plants for planting.....	19
3.6.2. Control methods.....	19
3.7. Uncertainty.....	19
4. Conclusions.....	19
References.....	21
Abbreviations.....	22
Appendix A – Methodological notes on Figure 2.....	23

1. Introduction

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

1.1.1. Background

Council Directive 2000/29/EC¹ 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) 2016/2031² 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 178/2002³, 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 criterion 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

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

(b) Bacteria

Citrus variegated chlorosis	<i>Xanthomonas campestris</i> pv. <i>oryzae</i> (Ishiyama)
<i>Erwinia stewartii</i> (Smith) Dye	Dye and pv. <i>oryzicola</i> (Fang, et al.) Dye

(c) Fungi

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

(d) Virus and virus-like organisms

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

Annex IIB

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

<i>Anthonomus grandis</i> (Boh.)	<i>Ips cembrae</i> Heer
<i>Cephalcia lariciphila</i> (Klug)	<i>Ips duplicatus</i> Sahlberg
<i>Dendroctonus micans</i> Kugelán	<i>Ips sexdentatus</i> Börner
<i>Gilpinia hercyniae</i> (Hartig)	<i>Ips typographus</i> Heer
<i>Gonipterus scutellatus</i> Gyll.	<i>Sternochetus mangiferae</i> Fabricius
<i>Ips amitinus</i> Eichhof	

(b) Bacteria

Curtobacterium flaccumfaciens pv. *flaccumfaciens*
(Hedges) Collins and Jones

(c) Fungi

Glomerella gossypii Edgerton

Hypoxyton mammatum (Wahl.) J. Miller

Gremmeniella abietina (Lag.) Morelet

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) <i>Carneocephala fulgida</i> Nottingham | 3) <i>Graphocephala atropunctata</i> (Signoret) |
| 2) <i>Draeculacephala minerva</i> Ball | |

Group of Tephritidae (non-EU) such as:

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

(c) Viruses and virus-like organisms

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

- | | |
|----------------------------------|--|
| 1) Andean potato latent virus | 4) Potato black ringspot virus |
| 2) Andean potato mottle virus | 5) Potato virus T |
| 3) Arracacha virus B, oca strain | 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 | 8) Peach yellows mycoplasma |
| 2) Cherry rasp leaf virus (American) | 9) Plum line pattern virus (American) |
| 3) Peach mosaic virus (American) | 10) Raspberry leaf curl virus (American) |
| 4) Peach phony rickettsia | 11) Strawberry witches' broom mycoplasma |
| 5) Peach rosette mosaic virus | 12) Non-EU viruses and virus-like organisms of <i>Cydonia</i> Mill., <i>Fragaria</i> L., <i>Malus</i> Mill., <i>Prunus</i> L., <i>Pyrus</i> L., <i>Ribes</i> L., <i>Rubus</i> L. and <i>Vitis</i> L. |
| 6) Peach rosette mycoplasma | |
| 7) Peach X-disease mycoplasma | |

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

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

- | | |
|--|--|
| 1) <i>Margarodes vitis</i> (Phillipi) | 3) <i>Margarodes prieskaensis</i> Jakubski |
| 2) <i>Margarodes vredendalensis</i> de Klerk | |

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**

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

(b) Fungi

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

(c) Viruses and virus-like organisms

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

(d) Parasitic plants

Arceuthobium spp. (non-EU)

Annex I A II

(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 I B

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

Leptinotarsa decemlineata Say

Liriomyza bryoniae (Kaltenbac)

(b) Viruses and virus-like organisms

Beet necrotic yellow vein virus

1.2. Interpretation of the Terms of Reference

Mycosphaerella laricis-leptolepis (in the Terms of Reference, misspelt as *Mycosphaerella laricis-leptolepis*) is one of a number of pests listed in the Appendices to the Terms of Reference (ToR) 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 European Union (EU).

The species was moved from the genus *Mycosphaerella* to the new genus *Mycodiella*, which was introduced to accommodate a few taxa clustering together in a well-supported clade based on large subunit (LSU) rRNA and distinguishable from the others based on DNA data (Crous et al., 2016; Videira et al., 2017). Therefore, the recommended valid name for the fungus is *Mycodiella laricis-leptolepidis* (Crous et al., 2016).

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *Mycodiella laricis-leptolepidis* was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database, using the scientific name of the pest as well as the previous accepted name *Mycosphaerella laricis-leptolepidis* as search terms. Relevant papers were reviewed, and 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, 2018).

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 (<http://ec.europa.eu/eurostat/web/agriculture/data/database>).

Information on EU Member State (MS) imports of *Larix* plants for planting from North America was 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 run by the Directorate General for Health and Food Safety (DG SANTE) 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 MSs and the phytosanitary measures taken to eradicate or avoid their spread.

2.2. Methodologies

The Panel performed the pest categorisation for *M. laricis-leptolepidis*, following guiding principles and steps presented in the European Food Safety Authority (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 ToR 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 RNQP. 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 RNQP which 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, 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? 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 RNQP. (A RNQP pest must be present in the risk assessment area)

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
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?
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 RNQP 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

Mycodiella laricis-leptolepidis (Kaz. Itô, K. Satô & M. Ota) Crous, *comb. nov.*, is a fungus of the family Mycosphaerellaceae (Crous et al., 2016).

The new genus *Mycodiella* was introduced to accommodate a few taxa, including *M. laricis-leptolepidis*, clustering together in a well-supported clade based on LSU rRNA and distinguishable from *Mycosphaerella* spp. based on DNA data (Crous et al., 2016; Videira et al., 2017).

The only known species synonym is *Mycosphaerella laricis-leptolepidis* (Index Fungorum, <http://www.indexfungorum.org/names/names.asp>). *Phoma yano-kubotae* and *Phyllosticta laricis* have been reported as spermogonial stages (EPPO, 1997, 2018).

3.1.2. Biology of the pest

M. laricis-leptolepidis causes a disease known as needle cast of Japanese larch (*Larix kampferi* = *Larix leptolepis*) in Japan (Peace, 1962). The fungus infects current season's larch needles exclusively by means of wind disseminated airborne ascospores, which are generated in black pseudothecia produced on fallen needles in contact with the soil (EPPO, 1997). Pseudothecia are produced during autumn and winter, with ascospore release and infections occurring from late-May to mid-July only at relative humidity of 100% (Ito et al., 1957; Pyun and La, 1970). Spore release continues for 70 days at 5–10°C but lasts about 13 days at 25°C (EPPO, 1997). An incubation period of 1–2 months has been reported (Ito et al., 1957; EPPO, 1997).

Uninfectious spermatia unsuitable to be disseminated by air currents and playing no role in disease transmission are generated in black spermogonia, which are produced on needles throughout the summer, from July onwards, while the needles are still attached to the tree.

M. laricis-leptolepidis could easily survive in conditions of low temperature with high humidity, but was vulnerable to high temperature with low humidity (Yang and Chen, 2015).

Disease severity has been related to some types of soils (e.g. acid soils) or soils with a relatively thick litter and A0 horizon (EPPO, 1997).

3.1.3. Intraspecific diversity

No information was found on the intraspecific diversity of *M. laricis-leptolepidis*.

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes

A description of *Mycosphaerella laricis-leptolepidis* useful for diagnostic purposes is available (Ito et al., 1957). The renamed species *Mycodiella laricis-leptolepidis* can be identified based on sequences of the ITS region (protocol and DNA sequence data given in Qbank - www.q-bank.eu).

3.2. Pest distribution

M. laricis-leptolepidis is reported from East Asia, i.e. China, Japan, North Korea and South Korea (EPPO, 2018) (Figure 1).

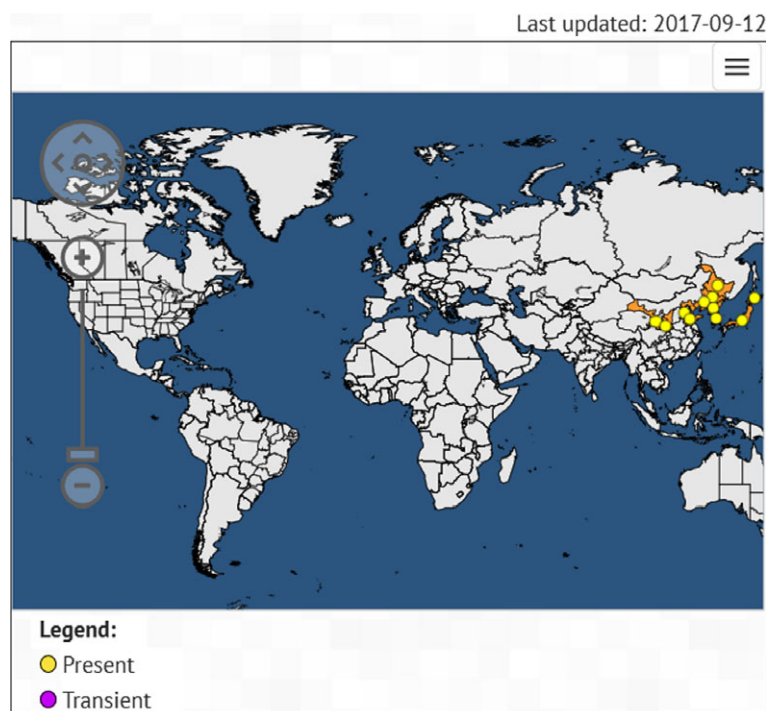


Figure 1: Global distribution map for *Mycodiella laricis-leptolepidis* (EPPO, 2018, accessed December 2017). There are no reports of transient populations

3.2.1. Pest distribution outside the EU

In addition to North and South Korea, the pathogen is reported as present in the following Chinese states: Gansu, Hebei, Heilongjiang, Jilin, Liaoning, Shaanxi, Shandong (EPPO, 2018). *M. laricis-leptolepidis* is also reported from Hokkaido and Honshu in Japan (EPPO, 2018). In all cases, the pathogen was reported as present, with no further detail.

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?

No, the pest is not reported to be present in the EU.

Slovenia reported the pest as absent in 2017 (EPPO, 2018). The pathogen is also listed as absent in the UK Plant Health Risk Register, as of March 2018 (<https://secure.fera.defra.gov.uk/phiw/riskRegister/viewPestRisks.cfm?csref=11887>). There are no reports of absence available to the Panel that have been confirmed by survey.

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

Mycodiella laricis-leptolepidis is listed in Council Directive 2000/29/EC as *Mycosphaerella laricis-leptolepis*. Details are presented in Tables 2 and 3.

Table 2: *Mycodiella laricis-leptolepidis* 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
(c)	Fungi
	Species
10.	<i>Mycosphaerella larici-leptolepis</i> Ito et al.

3.3.2. Legislation addressing the hosts of *M. laricis-leptolepidis*

Table 3: Regulated hosts and commodities that may involve *Mycodiella laricis-leptolepidis* in Annexes III, IV 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 <i>Abies</i> Mill., <i>Cedrus</i> Trew, <i>Chamaecyparis</i> Spach, <i>Juniperus</i> L., <i>Larix</i> Mill., <i>Picea</i> A. Dietr., <i>Pinus</i> L., <i>Pseudotsuga</i> Carr. and <i>Tsuga</i> Carr., other than fruit and seeds	Non-European countries
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 one	
1.1.	Plants of <i>Abies</i> Mill., <i>Larix</i> Mill., <i>Picea</i> A. Dietr., <i>Pinus</i> L. and <i>Pseudotsuga</i> Carr.	

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

The genus *Larix* is reported to be a host (EPPO, 2018). Major hosts for *M. laricis-leptolepidis* are the Kurile larch *Larix gmelinii* and the Japanese larch *Larix kaempferi* (EPPO, 2018), although this last species was previously reported as less susceptible (EPPO, 1997).

The European larch *Larix decidua* introduced in Japan also was susceptible to the disease (Imazeki and Ito, 1963). *L. decidua* has been reported either as a principal host (EPPO, 1997) or as a minor host (EPPO, 2018).

Artificial inoculations to other conifers have been unsuccessful (EPPO, 1997).

In Council Directive 2000/29/EC, the pest is not regulated on a particular host or commodity (Annex IAI).

3.4.2. Entry

Is the pest able to enter into the EU territory?

Yes, the pest could enter the EU through the introduction of plants for planting and cut branches of host species.

Host commodities on which the pathogen could enter the EU (EPPO, 2018) are:

- Plants for planting of *Larix* spp. (including bonsai)
- And cut branches of *Larix* spp.

The plants for planting pathway is closed due to the ban on importing into the EU *Larix* plants from non-European countries. However, in the ISEFOR database of traded plants for planting, there are two

records of shipments of *Larix* spp. nursery plants from China to the Netherlands (of 600 and 1,000 pieces, respectively, both in 2002).

As of February 2018, there were no records of interception of *M. laricis-leptolepidis* in the Europhyt database.

3.4.3. Establishment

Is the pest able to become established in the EU territory?

Yes, the pest could establish in the EU, as hosts and favourable climatic conditions are common.

3.4.3.1. EU distribution of main host plants

The natural distribution of European larch is mainly restricted to the Alps and the Carpathians (Figures 2 and 3), although the species has been planted elsewhere mostly in central and northern Europe (Figure 4).

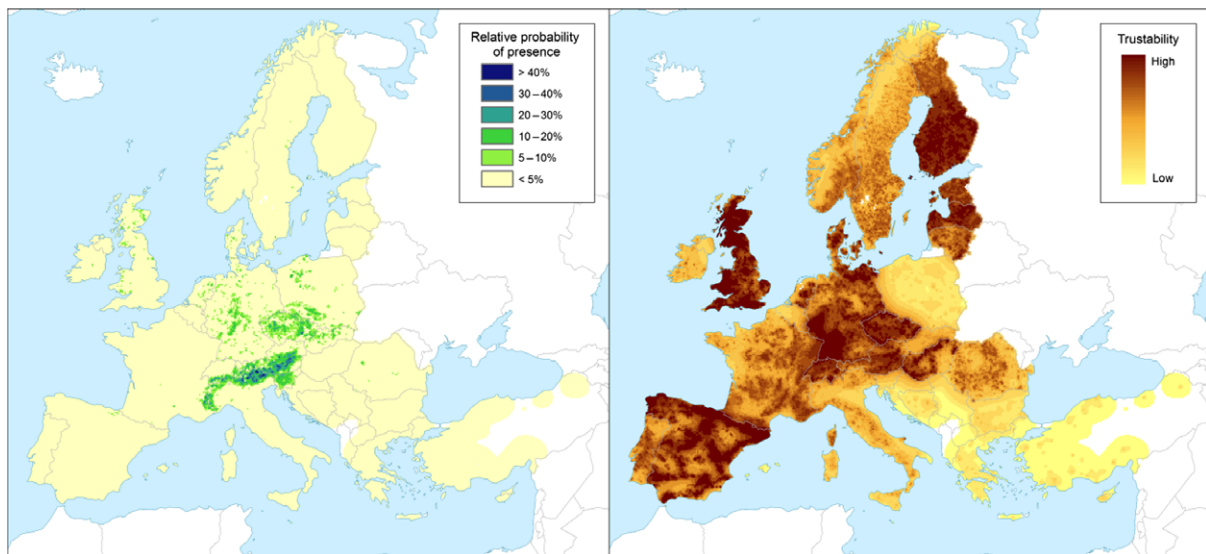


Figure 2: Left-hand panel: Relative probability of presence (RPP) of the genus *Larix* (based on data from the species: *L. decidua*, *L. kaempferi* and *L. sibirica*) in Europe, mapped at 100 km² resolution. The underlying data are from European-wide forest monitoring data sets and from national forestry inventories based on standard observation plots measuring in the order of hundreds m². 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 Joint Research Centre (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)

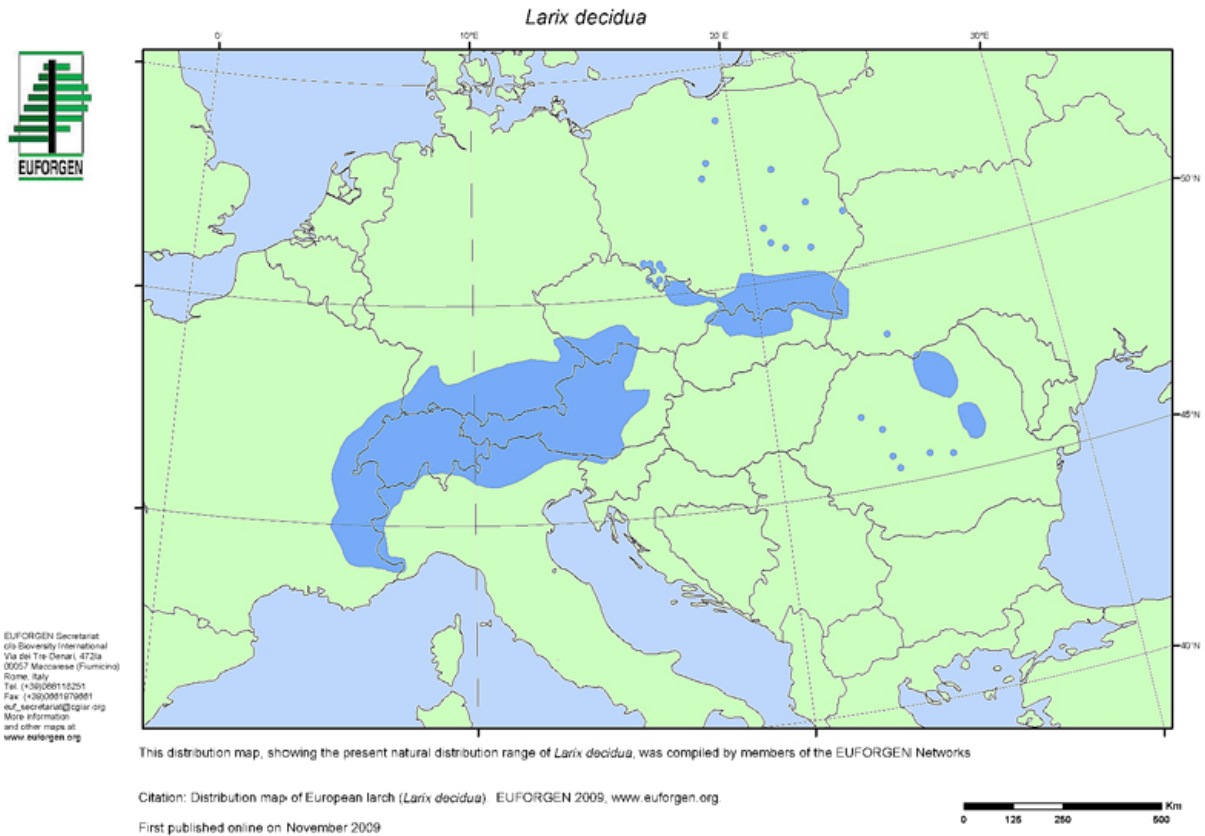


Figure 3: Native range of *Larix decidua* (map prepared by Euforgen in 2009). Blue dots represent isolated occurrences of the species

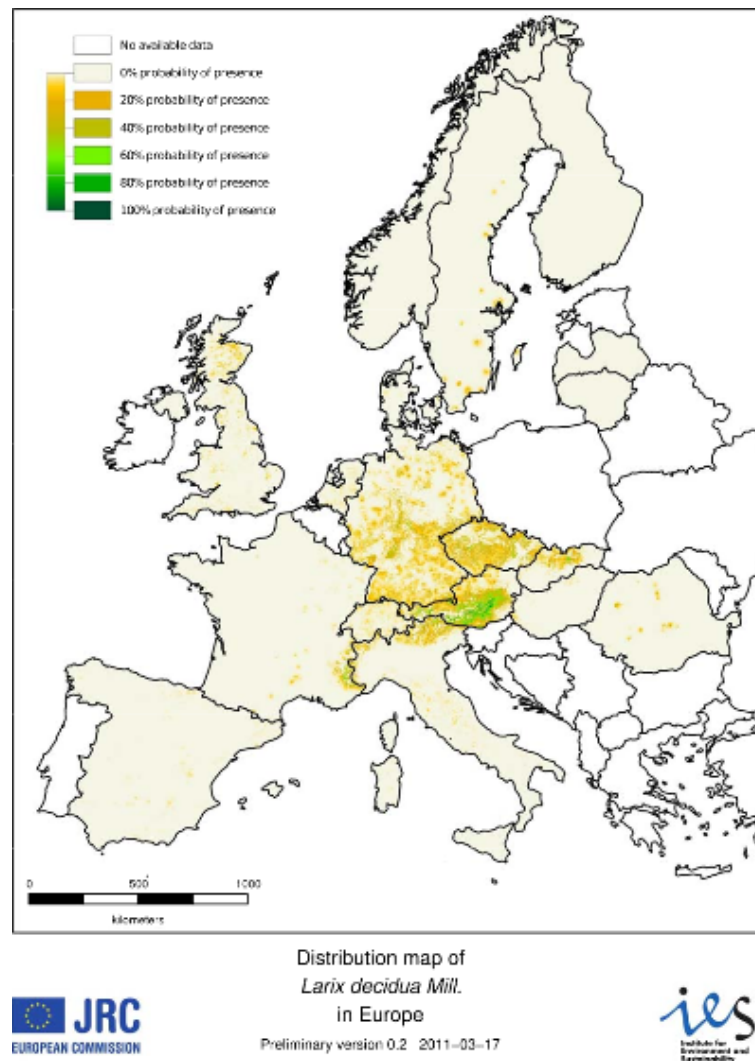


Figure 4: Distribution map of native stands and plantations of *Larix decidua* in Europe made by JRC, taken from EFSA PLH Panel (2011)

Based on data from the CABI Crop Protection Compendium, most European countries have been reported to host some plantations of Japanese larch (Figure 5) (EFSA PLH Panel, 2011). For instance, Japanese larch stands cover about 240,000 ha in Ireland, 125,000 ha in England, Wales and Scotland, 2,300 ha in Bavarian public forests and 240 hectares in Norway (EFSA PLH Panel, 2011).

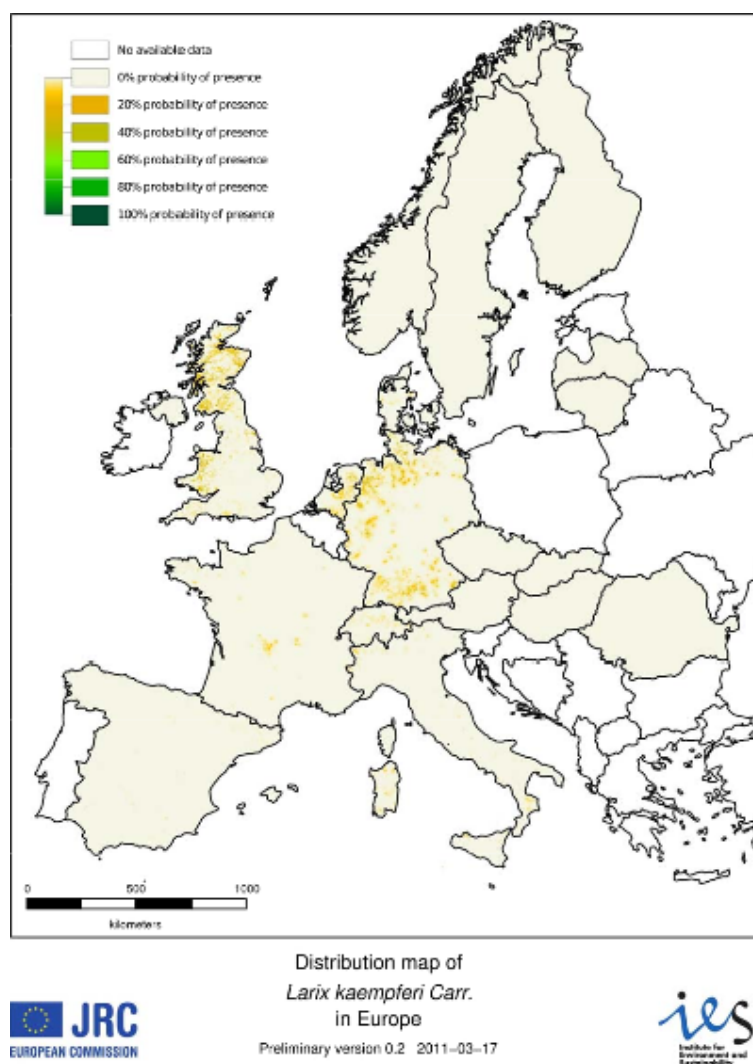


Figure 5: Distribution map of plantations of *Larix kaempferi* in Europe made by the JRC, taken from EFSA PLH Panel (2011)

3.4.3.2. Climatic conditions affecting establishment

The distribution of *M. laricis-leptolepidis* in East Asia (Figure 1; Section 3.2) covers areas with cold (continental) Köppen–Geiger climate types (Peel et al., 2007). These climate types overlap to a large extent with the distribution of the native *Larix* species in Europe. Therefore, climate is assumed not to be a limiting factor for the establishment of the pathogen in the EU.

3.4.4. Spread

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

Yes, by human movement of infected plants for planting and by dissemination of ascospores.

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

No, spread can occur both via plants for planting and natural spread.

Spread of the pathogen occurs by means of ascospores through air currents (EPPO, 1997). The potential range of spread through ascospores is unknown.

Although seedlings and saplings are generally less severely affected than trees in plantations (EPPO, 1997), spread is deemed to be possible through the movement of plants for planting (EPPO, 2018).

3.5. Impacts

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

Yes, the pest introduction could have an impact, especially in larch plantations.

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?⁴

Yes, the introduction of the pest could have an impact on the intended use of plants for planting.

In Japan, *M. laricis-leptolepidis* had increased in prevalence and, although disease severity varied widely between forests, it was reported to be the most important defoliator of *Larix* in Japan (EPPO, 1997). Usually, 10- to 20-year-old forests are severely infected. From far away, the infected trees appear as if having been scorched by fire or injured by late frost (Imazeki and Ito, 1963) (Figure 6). The pathogen may seriously defoliate larch trees in August, which can affect the growth of larch for three consecutive years and most seriously in the second year (Wang et al., 1999). Up to 80% reduction in wood volume occurs in heavily infected trees (EPPO, 1997).



Figure 6: Symptoms caused by *Mycodiella laricis-leptolepidis* on *Larix kaempferi* (photo by T. Kobayashi, Bugwood.org, available online at: <https://www.ipmimages.org/browse/detail.cfm?imgnum=1949023>)

⁴ 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, please see Section 3.6.2.

RNQPs: Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?

Yes, production in pest free areas can prevent pest presence on plants for planting.

3.6.1. Phytosanitary measures

Phytosanitary measures are currently applied to *Larix* spp. (see Section 3.3.2).

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

- An incubation period of 1–2 months has been reported (EPPO, 1997).

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

- It is uncertain whether chemical control in nurseries might just mask symptoms, hence allowing the movement of the pathogen via the trade in plants for planting.

3.6.2. Control methods

- Resistant clones may be used (EPPO, 1997).
- Treatments with fungicides in forest stands showed some efficacy (Fu et al., 2016), although at least in Japan, chemicals are not usually applied in plantations (EPPO, 1997).
- Removing or burning diseased fallen needles in spring may help controlling the disease (EPPO, 1997), although this approach may not be easily feasible.

3.7. Uncertainty

- There is limited information on the period of ascospore release and infection in relation to temperature.
- There is little information on the current distribution and especially on the level of impact of *M. laricis-leptolepidis* in East Asia.
- It is unknown if restricting the movement of plants for planting during dormancy (without needles) may be effective in reducing the risk of introduction of the pathogen.
- There is uncertainty about the potential range of spread through ascospores.

4. Conclusions

M. laricis-leptolepidis meets the criteria assessed by EFSA for consideration as a potential quarantine pest (Table 4).

Table 4: 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 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 pest as a species is clear	The identity of the pest as a species is clear	None

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
Absence/ presence of the pest in the EU territory (Section 3.2)	The pest is not reported to be present in the EU	The pest is not reported to be present in the EU	None
Regulatory status (Section 3.3)	<i>M. laricis-leptolepidis</i> is regulated by Council Directive 2000/29/EC (Annex IAI, as <i>Mycosphaerella laricis-leptolepis</i>) as a harmful organism whose introduction into and spread within all Member States shall be banned	<i>M. laricis-leptolepidis</i> is regulated by Council Directive 2000/29/EC (Annex IAI, as <i>Mycosphaerella laricis-leptolepis</i>) as a harmful organism whose introduction into and spread within all Member States shall be banned	None
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	<p>Entry: the pest could enter the EU via plants for planting and cut branches.</p> <p>Establishment: hosts and favourable climatic conditions are widespread in the risk assessment area.</p> <p>Spread: the pest would be able to spread following establishment by movement of infected plants for planting and cut branches, and natural spread.</p>	Plants for planting are not the main means of spread, as the pathogen could also be movement of cut branches and via natural spread.	<p>The effectiveness of restricting the movement of plants for planting during dormancy (without needles) in reducing the risk of introduction of the pathogen is unknown.</p> <p>The potential range of spread through ascospores is unknown</p>
Potential for consequences in the EU territory (Section 3.5)	The pest introduction would have economic and environmental impacts in natural forests and larch plantations	The pest introduction would have an impact on the intended use of <i>Larix</i> plants for planting.	There is little information on the level of impact of <i>M. laricis-leptolepidis</i> in East Asia
Available measures (Section 3.6)	<p>Import prohibition of <i>Larix</i> plants for planting is an available measure to reduce the risk of introduction</p> <p>The use of resistant/tolerant varieties can reduce the impacts, should the pathogen be introduced</p>	Production of plants for planting in pest-free areas can prevent pest presence on plants for planting	It is uncertain whether chemical control in nurseries might just mask symptoms, hence allowing the movement of the pathogen via the trade in plants for planting
Conclusion on pest categorisation (Section 4)	The criteria assessed by the Panel for consideration as a potential quarantine pest are met	The criterion on the pest presence in the EU is not met	
Aspects of assessment to focus on/ scenarios to address in future if appropriate	<p>The main knowledge gaps concern (i) the potential range of spread through ascospores and (ii) the level of impacts in the native range of the pathogen</p> <p>However, the present categorisation has explored most if not all of the data available to the Panel on these knowledge gaps</p>		

References

- Bossard M, Feranec J and Otahel J, 2000. CORINE land cover technical guide - Addendum 2000. Tech. Rep. 40, European Environment Agency. Available online: https://www.eea.europa.eu/ds_resolveuid/032TFUGVR
- Büttner G, Kosztra B, Maucha G and Pataki R, 2012. Implementation and achievements of CLC2006. Tech. rep., European Environment Agency. Available online: http://www.eea.europa.eu/ds_resolveuid/GQ4JECM8TB
- Chirici G, Bertini R, Travaglini D, Puletti N and Chiavetta U, 2011a. The common NFI database. In: Chirici G, Winter S and McRoberts RE (eds.). National forest inventories: contributions to forest biodiversity assessments. Springer, Berlin. pp. 99–119.
- Chirici G, McRoberts RE, Winter S, Barbati A, Brändli U-B, Abegg M, Beranova J, Rondeux J, Bertini R, Alberdi Asensio I and Condés S, 2011b. Harmonization tests. In: Chirici G, Winter S and McRoberts RE (eds.). National forest inventories: contributions to forest biodiversity assessments. Springer, Berlin. pp. 121–190.
- Crous PW, Wingfield MJ, Burgess TI, Hardy GE, Crane C, Barrett S, Cano- Lira JF, Le Roux JJ, Thangavel R, Guarro J, Stchigel AM, Martín MP, Alfredo DS, Barber PA, Barreto RW, Baseia IG, Cano-Canals J, Cheewangkoon R, Ferreira RJ, Gené J, Lechat C, Moreno G, Roets F, Shivas RG, Sousa JO, Tan YP, Wiederhold NP, Abell SE, Accioli T, Albizu JL, Alves JL, Antonioli ZI, Aplin N, Araújo J, Arzanlou M and Bezerra JD, Bouchara JP, Carlavilla JR, Castillo A, Castroagudín VL, Ceresini PC, Claridge GF, Coelho G, Coimbra VR, Costa LA, da Cunha KC, da Silva SS, Daniel R, de Beer ZW, Dueñas M, Edwards J, Enwistle P, Fiuza PO, Fournier J, García D, Gibertoni TB, Giraud S, Guevara-Suarez M, Gusmão LF, Haituk S, Heykoop M, Hirooka Y and Hofmann TA, Houbraken J, Hughes DP, Kautmanová I, Koppel O, Koukol O, Larsson E, Latha KP, Lee DH, Lisboa DO, Lisboa WS, López-Villalba Á, Maciel JL, Manimohan P, Manjón JL, Marincowitz S, Marney TS, Meijer M, Miller AN, Olariaga I, Paiva LM, Piepenbring M, Poveda-Molero JC, Raj KN, Raja HA and Rougeron A, Salcedo I, Samadi R, Santos TA, Scarlett K, Seifert KA, Shuttleworth LA, Silva GA, Silva M, Siqueira JP, Souza-Motta CM, Stephenson SL, Sutton DA, Tamakeaw N, Telleria MT, Valenzuela-Lopez N, Viljoen A, Visagie CM, Vizzini A, Wartchow F, Wingfield BD, Yurchenko E, Zamora JC and Groenewald JZ, 2016. Fungal Planet description sheets: 469–557. *Persoonia*, 37, 218–403.
- EFSA PLH Panel (EFSA Panel on Plant Health), 2010. PLH Guidance on a harmonised framework for pest risk assessment and the identification and evaluation of pest risk management options by EFSA. *EFSA Journal* 2010;8(2):1495, 66 pp. <https://doi.org/10.2903/j.efsa.2010.1495>
- EFSA PLH Panel (EFSA Panel on Plant Health), 2011. Scientific Opinion on the Pest Risk Analysis on *Phytophthora ramorum* prepared by the FP6 project RAPRA. *EFSA Journal* 2011;9(6):2186, 108 pp. <https://doi.org/10.2903/j.efsa.2011.2186>.
- EPPO (European and Mediterranean Plant Protection Organization), 1997. Data sheets on quarantine pests: *Mycosphaerella laricis-leptolepidis*. In: Smith IM, McNamara DG, Scott PR and Holderness M (eds.). *Quarantine Pests for Europe*, 2nd Edition. CABI/EPPO, Wallingford. p. 1425.
- EPPO (European and Mediterranean Plant Protection Organization), 2018. EPPO Global Database. Available online: <https://gd.eppo.int>
- Eschen R, Douma JC, Grégoire JC, Mayer F, Rigaux L and Potting RP, 2017. A risk categorisation and analysis of the geographic and temporal dynamics of the European import of plants for planting. *Biological Invasions*, 19, 3243–3257.
- FAO (Food and Agriculture Organization of the United Nations), 2004. ISPM (International Standards for Phytosanitary Measures) 21—Pest risk analysis of regulated non-quarantine pests. FAO, Rome, 30 pp. Available online: https://www.ippc.int/sites/default/files/documents//1323945746_ISPM_21_2004_En_2011-11-29_Refor.pdf
- FAO (Food and Agriculture Organization of the United Nations), 2013. ISPM (International Standards for Phytosanitary Measures) 11—Pest risk analysis for quarantine pests. FAO, Rome, 36 pp. Available online: https://www.ippc.int/sites/default/files/documents/20140512/ispm_11_2013_en_2014-04-30_201405121523-494.65%20KB.pdf
- Fu X, Wang Z, Wang X, Shi L, Zhang X, Li J, Yu HY, Chen L, Zhang Y and Li J, 2016. Studies on the combined prevention and control of larch diseases and shoot shoots. *Journal of Jilin Forestry Science and Technology*, 2, 30–34 [in Chinese]
- Hiederer R, Houston Durrant T, Granke O, Lambotte M, Lorenz M, Mignon B and Mues V, 2007. Forest focus monitoring database system - validation methodology. Vol. EUR 23020 EN of EUR – Scientific and Technical Research. Office for Official Publications of the European Communities. <https://doi.org/10.2788/51364>
- Hiederer R, Houston Durrant T and Micheli E, 2011. Evaluation of BioSoil demonstration project - Soil data analysis. Vol. 24729 of EUR - Scientific and Technical Research. Publications Office of the European Union. <https://doi.org/10.2788/56105>
- Houston Durrant T and Hiederer R, 2009. Applying quality assurance procedures to environmental monitoring data: a case study. *Journal of Environmental Monitoring*, 11(4), 774–781.
- Houston Durrant T, San-Miguel-Ayanz J, Schulte E and Suarez Meyer A, 2011. Evaluation of BioSoil demonstration project: forest biodiversity - Analysis of biodiversity module. Vol. 24777 of EUR – Scientific and Technical Research. Publications Office of the European Union. <https://doi.org/10.2788/84823>
- Imazeki R and Ito K, 1963. Internationally dangerous forest tree diseases - needle cast of larch. US Department of Agriculture Miscellaneous Publication No. 939, pp. 47–49.

- Ito K, Sato K and Otan N, 1957. Studies on the needle cast of Japanese larch - I. Life history of the causal fungus, *Mycosphaerella larici-leptolepis* sp. nov. Bulletin of the Government Forest Experiment, Meguro, Tokyo, Japan, 96, 69–88. [English abstract]
- Peace TR, 1962. *Pathology of Trees and Shrubs*. Oxford University Press, Oxford, UK.
- Peel MC, Finlayson BL and McMahon TA, 2007. Updated world map of the Köppen-Geiger climate classification. Hydrology and Earth System Sciences Discussions, 4, 439–473.
- Pyun BH and La YJ, 1970. Studies on the epidemiology and control of Larch needle cast disease caused by *Mycosphaerella larici-leptolepis*. Research Reports of the Forest Research Institute, Korea, 17, 29–34 [English abstract].
- de Rigo D, 2012. Semantic Array Programming for environmental modelling: application of the Mastrave library. In: Seppelt R, Voinov AA, Lange S, Bankamp D (eds.). International Environmental Modelling and Software Society (iEMSS) 2012 International Congress on Environmental Modelling and Software – Managing Resources of a Limited Planet: Pathways and Visions under Uncertainty, Sixth Biennial Meeting. Leipzig, Germany, pp. 1167–1176.
- de Rigo D, Caudullo G, Busetto L and San-Miguel-Ayanz J, 2014. Supporting EFSA assessment of the EU environmental suitability for exotic forestry pests: final report. EFSA Supporting Publications, 11(3), EN-434.
- de Rigo D, Caudullo G, Houston Durrant T and San-Miguel-Ayanz J, 2016. The European Atlas of Forest Tree Species: modelling, data and information on forest tree species. In: San-Miguel-Ayanz J, de Rigo D, Caudullo G, Houston Durrant T, Mauri A (eds.). European Atlas of Forest Tree Species. Publications Office of the European Union, Luxembourg, pp. e01aa69 +.
- de Rigo D, Caudullo G, San-Miguel-Ayanz J and Barredo JI, 2017. Robust modelling of the impacts of climate change on the habitat suitability of forest tree species. Publication Office of the European Union, 58 pp.
- San-Miguel-Ayanz J, 2016. The European Union Forest Strategy and the Forest Information System for Europe. In: San-Miguel-Ayanz J, de Rigo D, Caudullo G, Houston Durrant T, Mauri A (eds.). European Atlas of Forest Tree Species. Publication Office of the European Union, Luxembourg, pp. e012228 +.
- San-Miguel-Ayanz J, de Rigo D, Caudullo G, Houston Durrant T and Mauri A (eds.), 2016. European Atlas of Forest Tree Species. Publication Office of the European Union, Luxembourg.
- Videira SI, Groenewald JZ, Nakashima C, Braun U, Barreto RW, de Wit PJ and Crous PW, 2017. Mycosphaerellaceae – chaos or clarity? Studies in Mycology, 87, 257–421.
- Wang Z, Liu G, Wang Y, Jing T, Ren W and Wang J, 1999. Ecological effects of six diseases and insects on larch crown. Chinese Journal of Applied Ecology, 10, 703–706.
- Yang S and Chen S, 2015. Meteorological prediction of formation and development of larch caducous disease in the North-East of Inner Mongolia. Chinese Agricultural Science Bulletin, 31, 19–23.

Abbreviations

CLC	Corine Land Cover
C-SMFA	Constrained spatial multi-scale frequency analysis
DG SANTE	Directorate General for Health and Food Safety
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
LSU	large subunit
PLH	EFSA Panel on Plant Health
RNQP	Regulated non-quarantine pest
RPP	Relative probability of presence
ToR	Terms of Reference

Appendix A – Methodological notes on Figure 2

The relative probability of presence (RPP) reported here for *Larix* spp. in Figure 2 and in the European Atlas of Forest Tree Species (de Rigo et al., 2016; San-Miguel-Ayanz et al., 2016) is the probability of that genus 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 means of the constrained spatial multiscale frequency analysis (C-SMFA) (de Rigo et al., 2014, 2017) of species presence data reported in geolocated plots by different forest inventories.

A.1. Geolocated plot databases

The RPP models rely on five geodatabases that provide presence/absence data for tree species and genera: four European-wide forest monitoring data sets and a harmonised collection of records from national forest inventories (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 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 km² 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 approximately 375,000 sample points with a spatial resolution of 1 km²/pixel, covering 21 European countries (de Rigo et al., 2014, 2016).

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. 2152/2003⁵. 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 Joint Research Centre (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 dataset covers 30 European Countries with more than 8600 sample points.

A.1.3. BioSoil data set

This data set was produced by one of a number of demonstration studies performed 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 3300 sample points in 19 European Countries.

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

EUFGIS (<http://portal.eufgis.org>) is a smaller geodatabase providing 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.

A.1.5. Georeferenced Data on Genetic Diversity (GD²)

GD² (<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 km²) and filtered to a study area comprising 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 km² 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 km² 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 km² 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 performing' 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 km² 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 not to 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 codominant tree species which are homogeneously mixed, the RPP of both may be 100% (see e.g. the Glossary in San-Miguel-Ayaz 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).

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 km^2 and 625 km^2) by averaging the values in larger grid cells.