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## Pest categorisation of *Arrhenodes minutus*

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### Abstract

The Panel on Plant Health performed a pest categorisation of *Arrhenodes minutus*, a well-defined wood-boring insect species in the family Brentidae (Insecta: Coleoptera). It can be identified using taxonomic keys. *A. minutus* is only present in southern Canada and eastern USA down to Florida. The main host plants of *A. minutus* are species of the genera *Quercus*, *Ulmus*, *Fagus* and *Populus*. The pest larvae bore galleries in the wood, causing structural damage to the timber. The pest is also a vector of the quarantine pest *Breziella (Ceratocystis) fagacearum*. *A. minutus* most often lays its eggs in wounded parts of the trees where sap is oozing. The female bores minute holes with her snout and deposits one egg in each of them. The larvae bore a straight gallery against the grain. When the gallery nearly reaches the other side of the bole, it makes a sharp U-turn towards the point of origin. These galleries cause structural damage to the timber. The life cycle lasts generally 3 years, but some individuals develop in 2 years and a few require 4 years. The main pathways are wood and possibly plants for planting. Specific phytosanitary requirements exist for *Quercus* and *Populus* only, while *Ulmus* is regulated in relation to other pests. Establishment would be favoured by the wide distribution of host trees in the EU territory and by climatic conditions locally comparable to those of the pest's native range. *A. minutus* meets all the criteria assessed by EFSA for consideration as potential Union quarantine pest. The criteria for considering it as a potential Union regulated non-quarantine pest are not met since the species is absent from the EU.

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## 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.....	10
3.1. Identity and biology of the pest.....	10
3.1.1. Identity and taxonomy.....	10
3.1.2. Biology of the pest.....	11
3.1.3. Intraspecific diversity.....	11
3.1.4. Detection and identification of the pest.....	11
3.2. Pest distribution.....	11
3.2.1. Pest distribution outside the EU.....	11
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>Arrhenodes minutus</i> .....	13
3.3.3. Legislation addressing the organisms vectored by <i>Arrhenodes minutus</i> (Directive 2000/29/EC).....	15
3.4. Entry, establishment and spread in the EU.....	15
3.4.1. Host range.....	15
3.4.2. Entry.....	15
3.4.3. Establishment.....	16
3.4.3.1. EU distribution of main host plants.....	16
3.4.3.2. Climatic conditions affecting establishment.....	16
3.4.4. Spread.....	17
3.5. Impacts.....	17
3.6. Availability and limits of mitigation measures.....	17
3.6.1. Identification of additional measures.....	17
3.6.1.1. Additional control measures.....	17
3.6.1.2. Additional supporting measures.....	18
3.6.1.3. Biological or technical factors limiting the effectiveness of measures to prevent the entry, establishment and spread of the pest.....	19
3.7. Uncertainty.....	19
4. Conclusions.....	19
References.....	20
Abbreviations.....	22
Glossary.....	22
Appendix A – Methodological notes on Figure 2.....	24

## 1. Introduction

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

#### 1.1.1. Background

Council Directive 2000/29/EC<sup>1</sup> 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<sup>2</sup> 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<sup>3</sup>, 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.

<sup>1</sup> 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.

<sup>2</sup> 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.

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

<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 pruinosus</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> (Fabricius)
<i>Heliothis zea</i> (Boddie)	<i>Thrips palmi</i> Karny
<i>Hirschmanniella</i> spp., other than <i>Hirschmanniella 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> Speng. 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* (Kaltenbach)

##### (b) Viruses and virus-like organisms

Beet necrotic yellow vein virus

## 1.2. Interpretation of the Terms of Reference

*Arrhenodes minutus* 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 EU excluding Ceuta, Melilla and the outermost regions of Member States (MS) referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores.

## 2. Data and methodologies

### 2.1. Data

#### 2.1.1. Literature search

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

#### 2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from the Global Biodiversity Information Facility (GBIF) and relevant publications.

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



## 2.2. Methodologies

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

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

Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. All relevant criteria have to be met for the pest to potentially qualify either as a quarantine pest or as a 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 that needs to be addressed in the opinion. For the pests regulated in the protected zones only, the scope of the categorisation is the territory of the protected zone; thus, the criteria refer to the protected zone instead of the EU territory.

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

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

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
<b>Identity of the pest (Section 3.1)</b>	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?
<b>Absence/ presence of the pest in the EU territory (Section 3.2)</b>	Is the pest present in the EU territory? If present, is the pest widely distributed within the EU? Describe the pest distribution briefly!	Is the pest present in the EU territory? If not, it cannot be a protected zone quarantine organism	Is the pest present in the EU territory? If not, it cannot be a regulated non-quarantine pest. (A regulated non-quarantine pest must be present in the risk assessment area)
<b>Regulatory status (Section 3.3)</b>	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?

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
<b>Pest potential for entry, establishment and spread in the EU territory (Section 3.4)</b>	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!
<b>Potential for consequences in the EU territory (Section 3.5)</b>	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?
<b>Available measures (Section 3.6)</b>	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?
<b>Conclusion of pest categorisation (Section 4)</b>	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria assessed by EFSA above for consideration as potential protected zone quarantine pest were met, and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential regulated non-quarantine pest were met, and (2) if not, which one(s) were not met

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

### 3. Pest categorisation

#### 3.1. Identity and biology of the pest

##### 3.1.1. Identity and taxonomy

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

**Yes, *Arrhenodes minutus* is a clearly defined insect species in the order Coleoptera, family Brentidae.<sup>4</sup>**

<sup>4</sup> The family Brentidae is sometimes spelled 'Brenthidae', e.g. in Arnett (1968) and Arnett et al. (2002). In this opinion, we consistently use the spelling 'Brentidae'.

*Arrhenodes minutus* (Drury) is an insect of the family Brentidae (Insecta: Coleoptera). It has been described by Arnett (1968) who provides a taxonomic key to *A. minutus* in North America. The adult beetles are 7–25 mm long, the males being distinctly larger than the females. The body is shiny, elongated, reddish brown to almost black with yellow spots on the elytrae. The females have long and slender snouts, while the males show broad and flattened mandibles. The larvae are 12–24 mm long when fully grown, with a white, cylindrical body, three pairs of thoracic legs and one pair of prolegs at the end of their abdomen.

### 3.1.2. Biology of the pest

Some information is presented by Buchanan (1960), Sanborne (1983) and Solomon (1995). The adults are present from early May to August. They feed on sap oozing from the trees and have been observed to aggregate sometimes under loose bark at wounds. Oviposition occurs mostly at fresh wounds. The females chew minute holes with their snout in large wood vessels, depositing one egg in each hole, which is then often plugged with frass and a sticky secretion. In Ontario, Sanborne (1983) observed two periods of oviposition, from mid-June to late July and from early to mid-September. Newly hatched larvae bore directly into the wood, straight across the grain, and expel frass and sawdust through the oviposition hole at the beginning of their gallery. The diameter of the galleries increases as the larvae grow. The galleries almost reach the opposite side of the tree, and then make a sharp U-turn toward the entrances. Pupation occurs near the gallery's entry, from which the adult will emerge. In Missouri the life cycle is generally 3 years, but some individuals develop in 2 years and a few require 4 years (Buchanan, 1960).

### 3.1.3. Intraspecific diversity

There is no mention of intraspecific diversity in the scarce literature available.

### 3.1.4. Detection and identification of the pest

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

**Yes**, the gallery appearance allows the detection of the pest. A description of the adult and larval morphology is provided by Arnett (1968).

A taxonomic key is provided for identification by Arnett (1968). Useful drawings of the adults can also be found in Sanborne (1983) and Thomas (1996).

The pest can be detected by its galleries which start with a minute oviposition hole often located at wounds where sap is oozing from the wood. When the larvae grow, they expel their frass through their gallery's entrance. In sawn wood, the galleries can be seen to go straight across the grain through the bores and then back.

## 3.2. Pest distribution

### 3.2.1. Pest distribution outside the EU

*Arrhenodes minutus* is present in Southern Canada and Eastern USA down to Florida (Thomas, 1996) (Figure 1).



**Figure 1:** Distribution of *Arrhenodes minutus* based on GBIF (Global Biodiversity Information Facility) data (GBIF, online; accessed on 6 December 2018)

### 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**, *Arrhenodes minutus* has not been reported from the EU.

## 3.3. Regulatory status

### 3.3.1. Council Directive 2000/29/EC

*Arrhenodes minutus* is listed in Council Directive 2000/29/EC. Details are presented in Tables 2 and 3.

**Table 2:** *Arrhenodes minutus* in Council Directive 2000/29/EC

<b>Annex I, Part A</b>	<b>Harmful organisms whose introduction into, and spread within, all member states shall be banned</b>
<b>Section I</b>	<b>Harmful organisms not known to occur in any part of the community and relevant for the entire community</b>
(a)	Insects, mites and nematodes, at all stages of their development
	Species
6.	<i>Arrhenodes minutus</i> Drury

### 3.3.2. Legislation addressing the hosts of *Arrhenodes minutus*

*Arrhenodes minutus* is listed on Annex IAI, therefore its introduction into, and spread within, the EU is banned on all plant genera and commodities.

**Table 3:** Regulated hosts and commodities that may involve *Arrhenodes minutus* 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
2.	Plants of [...] <i>Quercus</i> L., with leaves, other than fruit and seeds	Non-European countries
3.	Plants of <i>Populus</i> L., with leaves, other than fruit and seeds	North American countries
Annex IV, Part A	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 all member states	
Section I	Plants, plant products and other objects originating outside the community	
	Plants, plant products and other objects	Special requirements
3.	<p>Wood of <i>Quercus</i> L., other than in the form of:</p> <ul style="list-style-type: none"> <li>— chips, particles, sawdust, shavings, wood waste and scrap,</li> <li>— casks, barrels, vats, tubs and other coopers' products and parts thereof, of wood, including staves where there is documented evidence that the wood has been produced or manufactured using heat treatment to achieve a minimum temperature of 176 °C for 20 minutes</li> <li>— Wood packaging material, in the form of packing cases, boxes, crates, drums and similar packings, pallets, box pallets and other load boards, pallet collars, dunnage, whether or not actually in use in the transport of objects of all kinds, except dunnage supporting consignments of wood, which is constructed from wood of the same type and quality as the wood in the consignment and which meets the same Union phytosanitary requirements as the wood in the consignment,</li> </ul> <p>but including wood which has not kept its natural round surface, originating in the USA.</p>	<p>Official statement that the wood:</p> <ul style="list-style-type: none"> <li>(a) is squared so as to remove entirely the rounded surface,</li> <li>or</li> <li>(b) is bark-free and the water content is less than 20% expressed as a percentage of the dry matter,</li> <li>or</li> <li>(c) is bark-free and has been disinfected by an appropriate hot-air or hot water treatment,</li> <li>or</li> <li>(d) if sawn, with or without residual bark attached, has undergone kiln-drying to below 20% moisture content, expressed as a percentage of dry matter, achieved through an appropriate time/temperature schedule. There shall be evidence thereof by a mark 'Kiln-dried' or 'KD' or another internationally recognised mark, put on the wood or on any wrapping in accordance with current usage.</li> </ul>
7.2.	<p>Whether or not listed among the CN codes in Annex V, Part B, wood in the form of chips, particles, sawdust, shavings, wood waste and scrap and obtained in whole or part from <i>Quercus</i> L. originating in the USA.</p>	<p>Official statement that the wood:</p> <ul style="list-style-type: none"> <li>(a) has undergone kiln-drying to below 20% moisture content, expressed as a percentage of dry matter achieved through an appropriate time/temperature schedule,</li> <li>or</li> <li>(b) has undergone an appropriate fumigation to a specification approved in accordance with the procedure laid down in Article 18.2. There shall be evidence of the fumigation by indicating on the certificates referred to in Article 13.1.(ii),</li> </ul>

		<p>the active ingredient, the minimum wood temperature, the rate (g/m<sup>3</sup>) and the exposure time (h),</p> <p>or</p> <p>(b) has undergone an appropriate heat treatment to achieve a minimum temperature of 56 °C for a minimum duration of 30 continuous minutes throughout the entire profile of the wood (including at its core), the latter to be indicated on the certificates referred to in Article 13.1.(ii).</p>
11.01.	Plants of <i>Quercus</i> L., other than fruit and seeds, originating in the USA	Without prejudice to the provisions applicable to the plants listed in Annex III(A)(2), official statement that the plants originate in areas known to be free from <i>Ceratocystis fagacearum</i> (Bretz) Hunt.
<b>Annex V</b>	<b>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</b>	
<b>Part A</b>	Plants, plant products and other objects originating in the Community	
<b>Section I</b>	Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community and which must be accompanied by a plant passport	
2.1.	Plants intended for planting, other than seeds, of the genera [...] <i>Quercus</i> L., [...] intended for planting, and other than bulbs, corms, rhizomes, seeds and tubers.	
<b>Section II</b>	<b>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</b>	
1.2.	Plants intended for planting, other than seeds, of [...] <i>Quercus</i> spp., other than <i>Quercus suber</i> [...]	
<b>Part B</b>	<b>Plants, plant products and other objects originating in territories, other than those territories referred to in Part A</b>	
<b>Section I</b>	<b>Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community</b>	
2.	Parts of plants, other than fruits and seeds, of [...] <i>Quercus</i> L.	
6.	<p>Wood within the meaning of the first subparagraph of Article 2(2), where it:</p> <p>(a) has been obtained in whole or part from one of the order, genera or species as described hereafter, except wood packaging material defined in Annex IV, Part A, Section I, Point 2:</p> <p>— <i>Quercus</i> L., including wood which has not kept its natural round surface, originating in the USA, except wood which meets the description referred to in (b) of CN code 4416 00 00 and where there is documented evidence that the wood has been processed or manufactured using a heat treatment to achieve a minimum temperature of 176 °C for 20 minutes</p> <p>(b) meets one of the following descriptions laid down in Annex I, Part two to Council Regulation (EEC) No 2658/87:</p> <p>4403 91 00 - Oak wood (<i>Quercus</i> spp.) in the rough, whether or not stripped of bark or sapwood, or roughly squared, other than treated with paint, stains, creosote or other preservatives</p> <p>4407 91 - Oak wood (<i>Quercus</i> spp.), sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm</p>	

### 3.3.3. Legislation addressing the organisms vectored by *Arrhenodes minutus* (Directive 2000/29/EC)

*Arrhenodes minutus* is a vector of the quarantine pest *Bretziella (Ceratozystis) fagacearum* (Table 4).

**Table 4:** Organisms vectored by *Arrhenodes minutus* Council Directive 2000/29/EC

<b>Annex I, Part A</b>	<b>Harmful organisms whose introduction into, and spread within, all member states shall be banned</b>
<b>Section I</b>	<b>Harmful organisms not known to occur in any part of the community and relevant for the entire community</b>
(c)	Fungi
	Species
1.	<i>Ceratozystis fagacearum</i>

## 3.4. Entry, establishment and spread in the EU

### 3.4.1. Host range

The pest attacks *Quercus*, *Ulmus*, *Populus* and *Fagus*. It might attack other hardwood tree species as well, as suggested by the fact that clusters of adults are found under loose bark of *Acer negundo* and *Gleditsia triacanthos* (Solomon, 1995).

### 3.4.2. Entry

*Is the pest able to enter into the EU territory? If yes, identify and list the pathways!*

**Yes**, the pest can enter via the wood and plants for planting pathways.

The pest could enter into the EU territory with the following pathways:

- Wood of *Quercus*, *Ulmus*, *Fagus* and *Populus*.
- Plants for planting of *Quercus*, *Ulmus*, *Fagus* and *Populus*. There is uncertainty regarding this pathway, as it has not been described in the literature nor identified in any interception.

For the following pathways, specific import requirements are currently specified in Annex III or Annex IV of 2000/29/EC:

- Wood of *Quercus* and *Populus* (specified treatments in Annex IV A.3 and 6)
- Chips and wood waste of *Quercus* (specified treatments in Annex IV A.7.2)
- Plants (with leaves) of *Quercus* and *Populus* (prohibited Annex III A.2 and 3)
- Plants, wood and bark of *Ulmus* are regulated in Annex III and IV in relation to other pests (*Agilus planipennis* and *Candidatus Phytoplasma ulmi*).

For all the other identified pathways (such as dormant *Quercus* plants without leaves, etc.), no import requirements are currently specified.<sup>5</sup>

There is one record of interception from 2005 of *A. minutus* in the Europhyt database, concerning a consignment of wood and bark of *Quercus alba* from USA into France.

<sup>5</sup> *Quercus*, *Ulmus*, *Fagus* and *Populus* are listed on Annex I of the Commission Implementing Regulation (EU) 2018/2019 of 18 December 2018 establishing a provisional list of high risk plants, plant products or other objects, within the meaning of Article 42 of Regulation (EU) 2016/2031 and a list of plants for which phytosanitary certificates are not required for introduction into the Union, within the meaning of Article 73 of that Regulation.

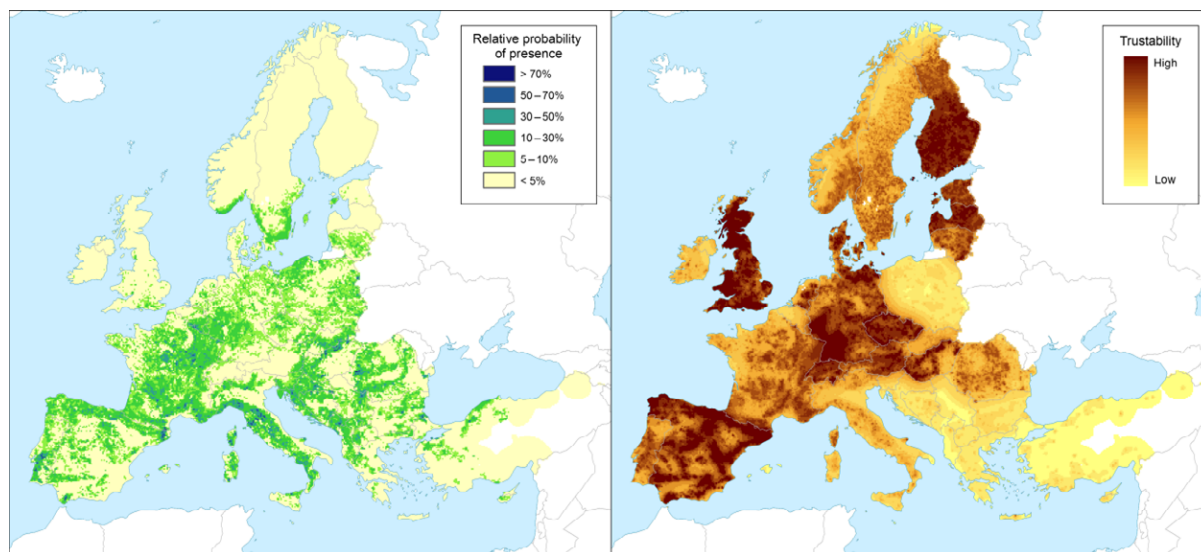
### 3.4.3. Establishment

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

**Yes**, *A. minutus* could establish in the EU territory as the climatic conditions in parts of the EU territory are comparable to those of its native range, and potential host plants are widespread.

#### 3.4.3.1. EU distribution of main host plants

Host species of *A. minutus* (see Section 3.4.1) are distributed throughout the EU territory. Figure 2 shows the distribution of *Quercus* spp. which are the only hosts for which more information is available (Buchanan, 1960; Sanborne, 1983).



**Figure 2:** Left panel: Relative probability of presence (RPP) of the genus *Quercus* (based on data from the species: *Quercus cerris*, *Q. petraea*, *Q. robur*, *Q. pubescens*, *Q. rubra*, *Q. frainetto*, *Q. ilex*, *Q. suber*, *Q. trojana*, *Q. virgiliana*, *Q. palustris*, *Q. pedunculiflora*, *Q. coccifera*, *Q. vulcanica*, *Q. faginea*, *Q. pyrenaica*, *Q. canariensis*, *Q. macrolepis*, *Q. dalechampii*, *Q. congesta*, *Quercus x streimii*, *Q. alnifolia*) in Europe, mapped at 100 km<sup>2</sup> 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<sup>2</sup>. 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 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

Many parts of Canada and the USA where *A. minutus* is established (Section 3.2.1 and Figure 1) have climatic conditions comparable to those occurring at least in parts of the EU.



### 3.4.4. Spread

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

**Yes**, the pest is able to spread in the EU via wood and plants for planting, as well as by flight.

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

**No**, plants for planting are not the main means for spread.

There are no data of its dispersal or spread ability. It is expected that the insect could probably spread by flight, although ability to fly is not known. Long distance spread could occur through the movement of wood and plants for planting. Hitchhiking in vehicles is probably also possible, although not reported.

### 3.5. Impacts

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

**Yes**, economic impact on timber production could be expected.

*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?<sup>6</sup>*

**Yes**, the presence of the pest on plants for planting may have an economic impact, as regards the intended use of those plants for planting.

Introduction of *A. minutus* in the EU is likely to have an economic impact on the EU as it is considered a significant pest in the USA. Substantial economic damage to timber growing for wood products has been reported from the USA (Solomon, 1995). Particular losses have been reported for lumber due to presence of wormholes made by feeding larvae (Solomon, 1995). Plants for planting could be a pathway (see Section 3.4.2), but so far no damage to plants for planting has been reported.

It is also mentioned that it can vector the oak wilt pathogen, *Bretziella fagacearum*, which is a severe disease of oak trees in the USA (EFSA, 2018a; Solomon, 1995).

### 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**, measures to prevent entry are shown in Sections 3.3 and in 3.6.1.

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

**Yes**, plants for planting originating from pest free areas.

#### 3.6.1. Identification of additional measures

Phytosanitary measures are currently applied to the main host plant species (see Section 3.3).

As an additional pre-entry measure for main host plant species, it could be considered growing plants in isolation. This measure has limitations as it is relevant mainly for smaller plants.

##### 3.6.1.1. Additional control measures

For wood and plants for planting from host species/genera that are not regulated (*Fagus* spp.) potential additional control measures may be required (Table 5).

<sup>6</sup> See Section 2.1 on what falls outside EFSA's remit.

**Table 5:** Selected control measures (a full list is available in EFSA PLH Panel, 2018a,b) for pest entry/establishment/spread/impact in relation to currently unregulated hosts and pathways. Control measures are measures that have a direct effect on pest abundance

Information sheet title (with hyperlink to information sheet if available)	Control measure summary	Risk component (entry/establishment/spread/impact)
<a href="#">Growing plants in isolation</a>	Description of possible exclusion conditions that could be implemented to isolate the crop from pests and if applicable relevant vectors. E.g. a dedicated structure such as glass or plastic greenhouses	Entry
<a href="#">Chemical treatments on consignments or during processing</a>	Use of chemical compounds that may be applied to plants or to plant products after harvest, during process or packaging operations and storage The treatments addressed in this information sheet are: a) fumigation; b) spraying/dipping pesticides; c) surface disinfectants; d) process additives; e) protective compounds	Entry
<a href="#">Roguing and pruning</a>	Removal of infested plant parts only, without affecting the viability of the plant	Establishment and spread
<a href="#">Heat and cold treatments</a>	Controlled temperature treatments aimed to kill or inactivate pests without causing any unacceptable prejudice to the treated material itself. The measures addressed in this information sheet are: autoclaving; steam; hot water; hot air; cold treatment	Entry
<a href="#">Conditions of transport</a>	Specific requirements for mode and timing of transport of commodities to prevent escape of the pest and/or contamination a) physical protection of consignment	Entry/establishment

### 3.6.1.2. Additional supporting measures

For wood and plants for planting from host species/genera that are not regulated (*Fagus* spp.), potential additional supporting measures may be required (Table 6).

**Table 6:** Selected supporting measures (a full list is available in EFSA PLH Panel, 2018a,b) in relation to currently unregulated hosts and pathways. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk reduction options that do not directly affect pest abundance

Information sheet title (with hyperlink to information sheet if available)	Supporting measure summary	Risk component (entry/establishment/spread/impact)
<a href="#">Inspection and trapping</a>	Inspection is defined as the official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (ISPM 5) The effectiveness of sampling and subsequent inspection to detect pests may be enhanced by including trapping and luring techniques	Entry and spread
<a href="#">Laboratory testing</a>	Examination, other than visual, to determine if pests are present using official diagnostic protocols. Diagnostic protocols describe the minimum requirements for reliable diagnosis of regulated pests	Entry

Information sheet title (with hyperlink to information sheet if available)	Supporting measure summary	Risk component (entry/ establishment/spread/ impact)
Sampling	According to ISPM 31, it is usually not feasible to inspect entire consignments, so phytosanitary inspection is performed mainly on samples obtained from a consignment. It is noted that the sampling concepts presented in this standard may also apply to other phytosanitary procedures, notably selection of units for testing For inspection, testing and/or surveillance purposes the sample may be taken according to a statistically based or a non-statistical sampling methodology	Entry
Phytosanitary certificate and plant passport	An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (ISPM 5) a) export certificate (import) b) plant passport (EU internal trade)	Entry and spread

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

The concealed life history of these beetles inside the wood does not make detection easy.

### 3.7. Uncertainty

- The pest’s ability to spread by flight or hitchhiking is not known.
- Although *A. minutus* is known to attack living trees, its capacity to colonise plants for planting is not documented.

## 4. Conclusions

*Arrhenodes minutus* meets all the criteria assessed by EFSA for consideration as potential Union quarantine pest (Table 7). The criteria for considering *A. minutus* as potential Union RNQPs are not met since it is not known to be present in the EU.

**Table 7:** 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
<b>Identity of the pest (Section 3.1)</b>	<i>A. minutus</i> is a clearly defined insect species in the order Coleoptera, family Brentidae	<i>A. minutus</i> is a clearly defined insect species in the order Coleoptera, family Brentidae	None
<b>Absence/presence of the pest in the EU territory (Section 3.2)</b>	<i>A. minutus</i> is not known to occur in the EU territory. It is only known from North America	<i>A. minutus</i> is not known to occur in the EU territory. It is only known from North America	None
<b>Regulatory status (Section 3.3)</b>	<i>A. minutus</i> is not present in the EU. It is listed on Annex IAI of Council Directive 2000/29/EC	<i>A. minutus</i> is not present in the EU. It is listed on Annex IAI of Council Directive 2000/29/EC	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
<b>Pest potential for entry, establishment and spread in the EU territory (Section 3.4)</b>	<i>A. minutus</i> has the potential to enter in wood and plants for planting, and become established and spread within the EU	<i>A. minutus</i> has the potential to enter in plants for planting and become established and spread within the EU	The pest's ability to spread (e.g. flight capacity and hitchhiking) is not known Although <i>A. minutus</i> is known to attack living trees, its capacity to colonise plants for planting is not documented
<b>Potential for consequences in the EU territory (Section 3.5)</b>	Introduction of <i>A. minutus</i> would have an economic impact as it damages plants growing for wood and it is a vector of oak wilt pathogen	<i>A. minutus</i> is associated with plants for planting (though it is not the main pathway) and is expected to have an impact on the use of those plants for planting	Although <i>A. minutus</i> is known to attack living trees, its capacity to colonise plants for planting is not documented
<b>Available measures (Section 3.6)</b>	There are measures available to prevent the entry of <i>A. minutus</i> in the EU, which are described in Council Directive 2000/29/EC and in section 3.6	Growing of plants in isolation or in pest free area or place of production	Although <i>A. minutus</i> is known to attack living trees, its capacity to colonise plants for planting is not documented
<b>Conclusion on pest categorisation (Section 4)</b>	<i>A. minutus</i> meets all criteria assessed by EFSA above for consideration as a potential quarantine pest	<i>A. minutus</i> does not meet all criteria assessed by EFSA above for consideration as a potential regulated non-quarantine pest as it is not present in EU	None
<b>Aspects of assessment to focus on/ scenarios to address in future if appropriate</b>	There is uncertainty regarding the role of plants for planting as a pathway		

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## Abbreviations

CLC	Corine Land Cover
C-SMFA	constrained spatial multi-scale frequency analysis
DG SANTÉ	Directorate General for Health and Food Safety
EUFGIS	European Information System on Forest Genetic Resources
FAO	Food and Agriculture Organization
GBIF	Global Biodiversity Information Facility
GD <sup>2</sup>	Georeferenced Data on Genetic Diversity
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
MS	Member State
PLH	EFSA Panel on Plant Health
PZ	protected zone
RNQP	regulated non-quarantine pest
RPP	relative probability of presence
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

## Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 1995, 2017)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 1995, 2017)
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO, 2017)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2017)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2017)
Impact (of a pest)	The impact of the pest on the crop output and quality and on the environment in the occupied spatial units
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO, 2017)
Measures	Control (of a pest) is defined in ISPM 5 (FAO 2017) as "Suppression, containment or eradication of a pest population" (FAO, 1995). Control measures are measures that have a direct effect on pest abundance. Supporting measures are organisational measures or procedures supporting the choice of appropriate Risk Reduction Options that do not directly affect pest abundance
Pathway	Any means that allows the entry or spread of a pest (FAO, 2017)
Phytosanitary measures	Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO, 2017)
Protected zones (PZ)	A Protected zone is an area recognised at EU level to be free from a harmful organism, which is established in one or more other parts of the Union
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2017)
Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party (FAO, 2017)

Risk reduction option (RRO)	A measure acting on pest introduction and/or pest spread and/or the magnitude of the biological impact of the pest should the pest be present. A RRO may become a phytosanitary measure, action or procedure according to the decision of the risk manager
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO 2017)

## Appendix A – Methodological notes on Figure 2

The relative probability of presence (RPP) reported here for *Quercus* 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 multi-scale 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 km<sup>2</sup> pixel size, using the ETRS89 Lambert Azimuthal Equal-Area as geospatial projection (EPSG: 3035, <http://spatialreference.org/ref/epsg/etrs89-etrs-aea/>).

#### 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 km<sup>2</sup>/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 2152/2003<sup>7</sup>. 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 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 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 providing information on tree species composition in over 3,200 forest plots in 34 European countries. The plots are part of a network of

<sup>7</sup> 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, pp. 1–8.



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 (GD<sup>2</sup>)

GD<sup>2</sup> (<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<sup>2</sup>) 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 km<sup>2</sup> 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<sup>2</sup> 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<sup>2</sup> 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 multi-scale 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 multi-scale 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 km<sup>2</sup> 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 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).

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.  $10 \times 10$  pixels or  $25 \times 25$  pixels, respectively, summarising the information for aggregated spatial cells of 100 and 625 km<sup>2</sup>) by averaging the values in larger grid cells.