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Pest categorisation of *Dendrolimus sibiricus*

EFSA Panel on Plant Health (PLH),

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Abstract

The Panel on Plant Health performed a pest categorisation of the Siberian moth, *Dendrolimus sibiricus* Tschetverikov (Lepidoptera: Lasiocampidae). *D. sibiricus* is a well-defined and distinguishable species, native to Asian Russia and northern regions of Kazakhstan, Mongolia, China and North Korea, and recognised as a severe pest of Pinaceae conifers, mainly larch (*Larix* spp.), fir (*Abies* spp.), spruce (*Picea* spp.), five-needle pines (*Pinus* spp.). It has also a potential to develop on non-native Pinaceae: *Cedrus*, *Pseudotsuga*, *Tsuga*. It defoliates healthy trees and kills thousands of hectares of forests. It is absent from the EU and is listed as a quarantine pest in Annex IAI of Directive 2000/29/EC. Plants for planting, branches of conifers and non-squared wood from its distribution range are considered as pathways for the pest, which can also disperse by flight over tens of kilometres. The females produce sex pheromones. Adults do not feed and can survive for about 2 weeks. One female lays up to 400 eggs, attaching them to needles. One generation usually develops in 2–3 years, with larvae passing winter diapause and some undergoing facultative summer diapause. Exceptionally, 1-year generations may occur if the number of degree-days above 10°C is higher than 2,200. Larvae feed on needles through 5–6 instars and pupate in a cocoon on tree branches. Mature larvae have urticating setae on thoracic segments that protect them from enemies and may cause allergic reactions in humans and animals. The contradictory studies regarding the climatic requirements of *D. sibiricus* make the issue of its establishment in most of the EU territory uncertain, although its host trees are widely present. All criteria for considering *D. sibiricus* as a potential quarantine pest are met. The species is presently absent from the EU, and thus, the criteria for consideration as a potential regulated non-quarantine pest are not met.

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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.....	12
3.1.4. Detection and identification of the pest.....	12
3.2. Pest distribution.....	12
3.2.1. Pest distribution outside the EU.....	12
3.2.2. Pest distribution in the EU.....	14
3.3. Regulatory status.....	14
3.3.1. Council Directive 2000/29/EC.....	14
3.3.2. Legislation addressing the hosts of <i>Dendrolimus sibiricus</i>	14
3.4. Entry, establishment and spread in the EU.....	18
3.4.1. Host range.....	18
3.4.2. Entry.....	19
3.4.3. Establishment.....	19
3.4.3.1. EU distribution of main host plants.....	19
3.4.3.2. Climatic conditions affecting establishment.....	20
3.4.4. Spread.....	22
3.5. Impacts.....	22
3.6. Availability and limits of mitigation measures.....	23
3.6.1. Phytosanitary measures.....	23
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.....	24
3.6.2. Pest control methods.....	24
3.7. Uncertainty.....	24
4. Conclusions.....	24
References.....	25
Abbreviations.....	29

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 criteria to be taken particularly under consideration for these cases, is the analysis of host pest combination, investigation of pathways, the damages occurring and the relevant impact.

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

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

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

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

1.1.2.1. Terms of Reference: Appendix 1

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

Annex IIAI

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

<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> Kugelan	<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 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> (Fabricus)
<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> 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 (Kaltenbach)

(b) Viruses and virus-like organisms

Beet necrotic yellow vein virus

1.2. Interpretation of the Terms of Reference

Dendrolimus sibiricus 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 for the area of the European Union (EU) excluding Ceuta, Melilla and the outermost regions of Member States (MSs) 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 *D. sibiricus* 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 European and Mediterranean Plant Protection Organization (EPPO) Global Database (EPPO, 2018) and relevant publications.

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

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

2.2. Methodologies

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

In accordance with the guidance on a harmonised framework for pest risk assessment in the EU (EFSA PLH Panel, 2010), this work was initiated following an evaluation of the EU plant health regime. Therefore, to facilitate the decision-making process, in the conclusions of the pest categorisation, the Panel addresses explicitly each criterion for a Union quarantine pest and for a Union regulated non-quarantine pest in accordance with Regulation (EU) 2016/2031 on protective measures against pests of plants, and includes additional information required in accordance with the specific terms of reference received by the European Commission. In addition, for each conclusion, the Panel provides a short description of its associated uncertainty.

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

It should be noted that the Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, the Panel will present a summary of the observed pest impacts. Economic impacts are expressed in terms of yield and quality losses and not in monetary terms, whereas addressing social impacts is outside the remit of the Panel, in agreement with 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 regulated non-quarantine pest. (A regulated non-quarantine pest must be present in the risk assessment area)
Regulatory status (Section 3.3)	If the pest is present in the EU but not widely distributed in the risk assessment area, it should be under official control or expected to be under official control in the near future	The protected zone system aligns with the pest free area system under the International Plant Protection Convention (IPPC) The pest satisfies the IPPC definition of a quarantine pest that is not present in the risk assessment area (i.e. protected zone)	Is the pest regulated as a quarantine pest? If currently regulated as a quarantine pest, are there grounds to consider its status could be revoked?

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in, and spread within, the EU territory? If yes, briefly list the pathways!	Is the pest able to enter into, become established in, and spread within, the 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 regulated non-quarantine pest were met, and (2) if not, which one(s) were not met

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

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

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

Yes, the identity of *Dendrolimus sibiricus* is established. The pest can be identified using taxonomic keys developed by Rozhkov (1963).

Dendrolimus sibiricus Tschetverikov is an insect of the family Lasiocampidae, subfamily Lasiocampinae.

Morphologically *D. sibiricus* has many similarities to the related species, *Dendrolimus superans* that co-occurs in the Russian Far East and China (Rozhkov, 1963). Rozhkov (1963, 1981) considered a single species, *D. superans*, with two subspecies: *D. superans sibiricus* Tschetverikov and *D. superans albolineatus* Butler. In the current taxonomy, they became, respectively, *D. sibiricus* and *D. superans*. *D. sibiricus* can be identified using taxonomic keys developed by Rozhkov (1963).

Nuclear internal transcribed spacer 2 (ITS2) and mitochondrial COI phylogenies show that *D. sibiricus* and *D. superans* are the closest neighbours in the genus and share a common ancestor (Kononov et al., 2016). The same authors suggest the possibility of cross-hybridisation between *D. sibiricus* and *D. pini*. The species are sympatric in a part of their range and respond to the same synthetic sex pheromones (Baranchikov et al., 2006). *D. sibiricus* and *D. pini* have a very similar external morphology, but can easily be differentiated based on the structure of male genitalia (Baranchikov et al., 2006). In 2008, a new species, *D. kilmez*, was described from the Kirov Oblast, Western Russia (Mikkola and Ståhls, 2008). However, according to nuclear (ITS2) and mitochondrial (COI, COII) markers, *D. kilmez* forms one single cluster with *D. pini*, which led to the conclusion that *D. kilmez* is in fact *D. pini* (Kononov et al., 2016).

3.1.2. Biology of the pest

The biology of *D. sibiricus* is well studied in northeast Asia, its native range, where the most extensive outbreaks have been recorded in the last century (Florov, 1938; Prozorov, 1952; Boldaruev, 1955; Geispitz, 1957; Rozhkov, 1963, 1981; Vshivkova, 1976, 2004; Kirichenko, 2002; Baranchikov and Kirichenko, 2002a,b; Kirichenko and Baranchikov, 2004a,b, 2005, 2007).

Its life cycle usually varies from 2 to 3 years (Prozorov, 1952; Boldaruev, 1955; Rozhkov, 1963). The number of degree-days above 10°C necessary to complete development in 2 years is assumed to range between 1,200 (Kondakov, 1974) and 2,000 (Prozorov, 1952). Okunev (1955) reported that *D. sibiricus* switches into a 1-year life cycle if the number of degree-days is higher than 2,200.

Adults lay eggs (about 3 mm in diameter) from the middle of June to the beginning of July. One female may lay 150–400 eggs (usually 200–300) attaching them by bunches (from 3–10 up to 100 eggs) to host plant needles and twigs. Bigger females lay significantly more eggs than small ones (Boldaruev, 1955; Rozhkov, 1963; Kirichenko and Baranchikov, 2004b). Egg development takes 13–22 days. Larvae have five to six instars (exceptionally seven). Neonate larvae are about 3–4 mm in length. Body length of mature larvae may reach 100 mm (but usually varies from 50 to 60 mm). Larvae of young and middle instars (I–IV) have better growth, development and survival in groups, whereas older larvae (V–VI instars) prefer staying individually and therefore they effectively spread in the tree crowns (Kirichenko and Baranchikov, 2004a,b).

A light/dark (LD) 12:12 h photoperiod initiates larval diapause (Geispitz, 1957) and diapausing larvae overwinter once or twice depending on the length of their life cycle (Boldaruev, 1955; Rozhkov, 1963). In the first year, larvae develop to the second, third or fourth instar before coiling up in the litter and overwintering. They appear in early spring of the following year (late April–early May), feed extensively and complete their development in June, except those which overwinter a second time (Rozhkov, 1963). During this period, they cause the most significant damage since mature larvae (the two last instars) consume nearly 90% of all biomass eaten during the whole larval stage (Kirichenko, 2002; Baranchikov et al., 2002a,b).

Larvae that overwinter their first winter in the second–third instars are usually not able to complete development in the spring of the following year, so that in summer they enter summer diapause (characterised by slow movement and development in the tree crowns) and overwinter in the forest floor in the fourth or fifth instar to complete their development and pupate in the third year (Baranchikov and Kirichenko, 2002a, b). Such a complex life cycle requires 5–11 months of active larvae development.

Fifth and sixth instar larvae have urticating setae (on II and III body segments, dorsal side) that seems to serve for protection against predators and that may cause allergic reactions in humans (Rozhkov, 1963). Pupation takes place on twigs and branches of host plants in a thick silk cocoon covered by urticating setae. The larvae spend about 4 days for spinning their cocoon (Rozhkov, 1963). The pupal stage takes from 10 to 21 days (Rozhkov, 1963; Kirichenko, 2002). Adults do not feed and live 5–18 days (usually 7–10 days) (Prozorov, 1952; Rozhkov, 1963). Females are usually bigger than males (wingspan 40–80 mm). In field experiments, it was shown that adults may fly up to 15 km

(Pet'ko, 2004). Distribution of individuals up to 50 km was observed (Boldaruev, 1969). Rozhkov (1963) proposed a mathematical model taking into account wing power capacity and moth weight, and estimated that females may disperse over up to 120 km and males up to 280 km, which however needs to be proven by field observations.

3.1.3. Intraspecific diversity

Several races have been described in the literature related to *D. superans sibiricus* (presently *D. sibiricus*): *D. sibiricus sibiricus*, *D. s. mandshuricus*, *D. s. uralensis* (Florov, 1938, 1948), larch, fir and ussuri races (Rozhkov, 1963), larch, fir and five-needle pine races (Boldaruev, 1955; Ilyinskiy, 1965), based mainly on their biology (life cycle duration and host plant 'specialisation') and in some cases on adult morphology (wing colour patterns and minor variability in male genitalia). No differences were found in the responses of the larch, fir and five-needle pine races to the synthetic sex pheromones used to monitor *D. sibiricus* (Baranchikov et al., 2002a,b). These authors also found that these three races had the same host plant preferences.

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, several methods exist for detection and monitoring of *D. sibiricus*, which could be potentially used for field surveys.

Synthetic sex attractants were identified (Klun et al., 2000; Pletnev et al., 2000) and pheromone traps were designed and tested (Baranchikov et al., 2004a,b; Pet'ko, 2004; Pet'ko et al., 2004, 2016). They can be used from June to July, when adults emerge. This method is sensitive and may allow detection even at low population density (Pet'ko, 2004; Pet'ko et al., 2004). However, *D. pini* has also been observed to respond to these attractants (Pet'ko et al., 2004; Baranchikov et al., 2006; Petko et al., 2016).

Sampling of larvae can be done but at low population densities the probability to find larvae is extremely reduced (Pet'ko, 2004). Mature larvae can be found by beating the main trunk of potential host plants in late April–early June (Ilyinskiy, 1965). Alternatively, larvae can also be searched in late September–October in the litter under damaged trees, where they overwinter (Rozhkov, 1963).

Adults can be identified to species level using the detailed taxonomic keys developed by Rozhkov (1963). Both adults and larvae can be identified through DNA barcoding (the nucleotide sequences of the COI mitochondrial gene), or ITS2 spacer, of nuclear ribosomal gene sequence, by comparison with reference specimens of *D. sibiricus* originating from Russia (Mikkola and Ståhls, 2008; Kononov et al., 2016) and deposited in Genbank (NCBI, 2018).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

Dendrolimus sibiricus is present in Russia, China, Kazakhstan, Democratic People's Republic of Korea, Republic of Korea and Mongolia (Table 2, Figures 1–2).

Table 2: Current distribution of *Dendrolimus sibiricus* outside Europe based on the information from the EPPO Global Database and additional sources

Country (including sub-national states)	EPPO global database Last updated: 6 April 2018 Date accessed: 15 May 2018	Additional information based on Rozhkov (1963), Kononov et al. (2016)
China (Heilongjiang, Jilin, Liaoning, Neimenggu)	Present, restricted distribution	Present, north-east, along the border with Russia
Kazakhstan	Present, restricted distribution	Very restricted to the most north-east corner of the country sharing border with Russia and China. Otherwise, <i>D. pini</i> is present in the country along the border with Russia

Country (including sub-national states)	EPPO global database Last updated: 6 April 2018 Date accessed: 15 May 2018	Additional information based on Rozhkov (1963), Kononov et al. (2016)
Democratic People's Republic of Korea	Present, no details	Very restricted to the north-east of North Korea. Otherwise the related species, <i>D. spectabilis</i> , is widely spread in North Korea
Republic of Korea	Present, no details	Very restricted to the north-east of North Korea. Otherwise the related species, <i>D. spectabilis</i> , is widely spread in North and South Korea
Mongolia	Present, restricted distribution	Present, north-east along the border with Russia
Russia (Central Russia) (Far East, eastern & western Siberia)	Present, restricted distribution	Present. Western part of Russia: restricted distribution, from the Ural Mountains to Kirov Oblast, where it is overlapped with the closely related species, <i>D. pini</i> . Siberia: wide distribution – from Tyumen oblast on the west to Transbaikalia on the east, where it also co-occurs with <i>D. pini</i> (except northern and eastern regions). Russian Far East: distributed in the southern and central regions, and on the Island of Sakhalin. Along the border with China, its range is overlapped with that of closely related <i>D. superans</i> that further has a wide distribution in Japan

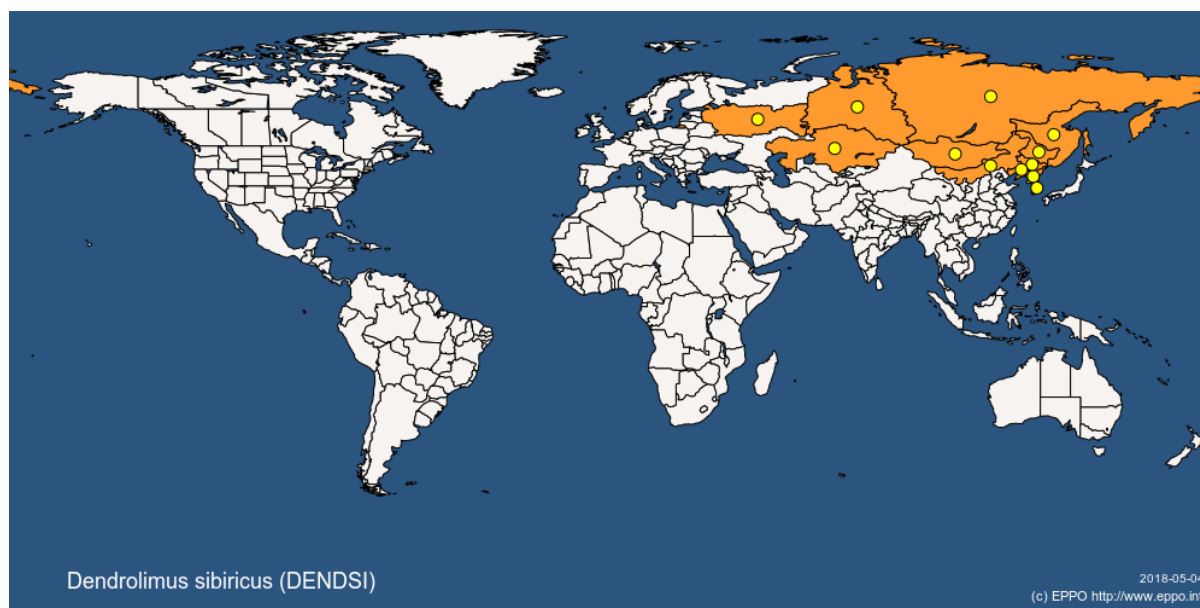


Figure 1: Global distribution map for *Dendrolimus sibiricus* (extracted from the EPPO Global Database accessed on 4 May 2018)

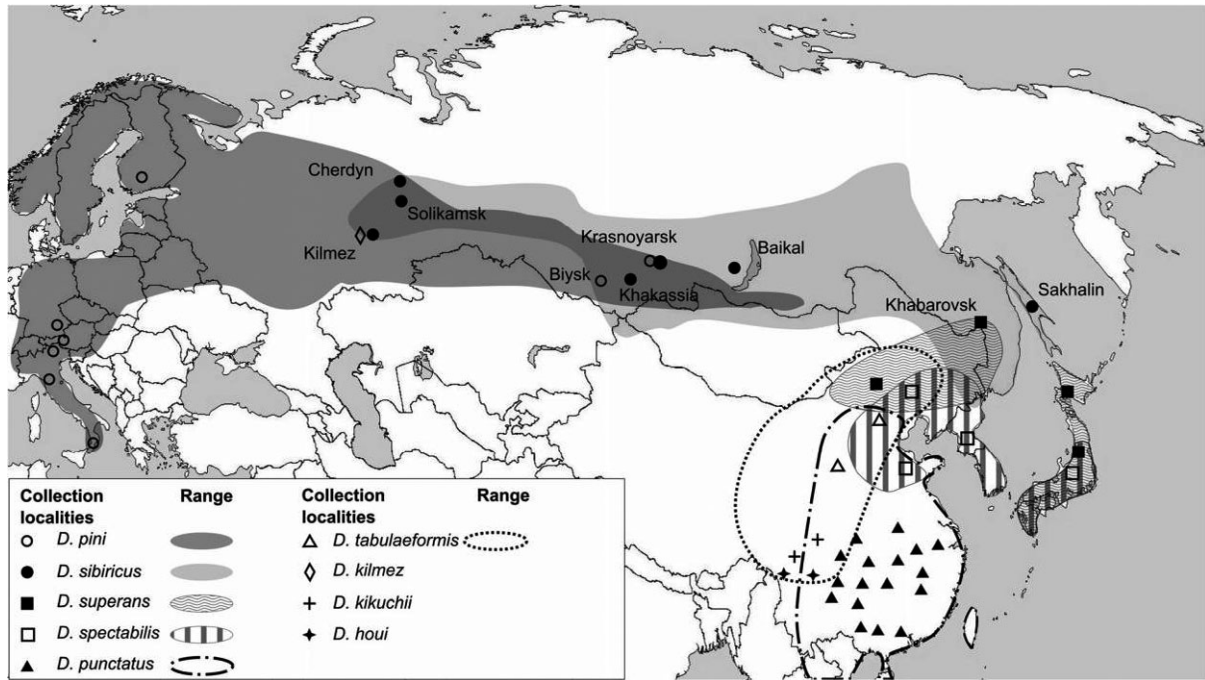


Figure 2: Distribution of *Dendrolimus sibiricus* and other related *Dendrolimus* species in Eurasia (from Kononov et al., 2016)

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, *D. sibiricus* is not reported from the EU territory.

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

Dendrolimus sibiricus is listed in Council Directive 2000/29/EC. Details are presented in Table 3.

Table 3: *Dendrolimus sibiricus* in Council Directive 2000/29/EC

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

3.3.2. Legislation addressing the hosts of *Dendrolimus sibiricus*

Dendrolimus sibiricus is an Annex IAI pest, which implies that it is regulated for all plant genera and commodities. Table 4 shows the relevant regulation related to its hosts.

Table 4: Regulated hosts and commodities that may involve *Dendrolimus sibiricus*. 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
	Plants of <i>Abies</i> Mill., <i>Cedrus</i> Trew, [...], <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 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
1.1.	<p>Whether or not listed among the CN codes in Annex V, Part B, wood of conifers (Coniferales), except that of <i>Thuja</i> L. and <i>Taxus</i> L., other than in the form of:</p> <ul style="list-style-type: none"> – chips, particles, sawdust, shavings, wood waste and scrap obtained in whole or part from these conifers, – 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, – wood of <i>Libocedrus decurrens</i> Torr. where there is evidence that the wood has been processed or manufactured for pencils using heat treatment to achieve a minimum temperature of 82 ° C for a seven to eight-day period, <p>but including that which has not kept its natural round surface, originating in Canada, China, Japan, the Republic of Korea, Mexico, Taiwan and the USA, where <i>Bursaphelenchus xylophilus</i> (Steiner et Bühner) Nickle et al. is known to occur.</p>	<p>Official statement that the wood has undergone an appropriate:</p> <ul style="list-style-type: none"> (a) 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). There shall be evidence thereof by a mark 'HT' put on the wood or on any wrapping in accordance with current usage, and on the certificates referred to in Article 13.1.(ii), or (b) fumigation to a specification approved in accordance with the procedure laid down in Article 18.2. There shall be evidence thereof by indicating on the certificates referred to in Article 13.1.(ii), the active ingredient, the minimum wood temperature, the rate (g/m³) and the exposure time (h), or (c) chemical pressure impregnation with a product approved in accordance with the procedure laid down in Article 18.2. There shall be evidence thereof by indicating on the certificates referred to in Article 13.1.(ii), the active ingredient, the pressure (psi or kPa) and the concentration (%), and <p>official statement that subsequent to its treatment the wood was transported until leaving the country issuing that statement outside of the flight season of the vector <i>Monochamus</i>, taking into account a safety margin of four additional weeks at the beginning and at the end of the expected flight season, or, except in the case of wood free from any bark, with a protective covering ensuring that infestation with <i>Bursaphelenchus xylophilus</i> (Steiner et Bühner) Nickle et al. or its vector cannot occur.</p>

<p>1.5.</p> <p>Whether or not listed among the CN codes in Annex V, Part B, wood of conifers (Coniferales), other than in the form of:</p> <ul style="list-style-type: none"> – chips, particles, sawdust, shavings, wood waste and scrap obtained in whole or part from these conifers, – 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 actually in use or not 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, <p>but including that which has not kept its natural round surface, originating in Russia, Kazakhstan and Turkey.</p>	<p>Official statement that the wood:</p> <p>(a) originates in areas known to be free from:</p> <ul style="list-style-type: none"> – <i>Monochamus</i> spp. (non-European) – <i>Pissodes</i> spp. (non-European) – Scolytidae spp. (non-European) <p>The area shall be mentioned on the certificates referred to in Article 13.1.(ii), under the rubric 'place of origin,'</p> <p>or [. . .]</p> <p>or</p> <p>(c) 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 'K.D.' or another internationally recognised mark, put on the wood or on any wrapping in accordance with the current usage,</p> <p>or</p> <p>(d) 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). There shall be evidence thereof by a mark 'HT' put on the wood or on any wrapping in accordance with current usage, and on the certificates referred to in Article 13.1.(ii),</p> <p>or</p> <p>(e) has undergone an appropriate fumigation to a specification approved in accordance with the procedure laid down in Article 18.2. There shall be evidence thereof by indicating on the certificates referred to in Article 13.1.(ii), the active ingredient, the minimum wood temperature, the rate (g/m³) and the exposure time (h),</p> <p>or</p> <p>(f) has undergone an appropriate chemical pressure impregnation with a product approved in accordance with the procedure laid down in Article 18.2. There shall be evidence thereof by indicating on the certificates referred to in Article 13.1.(ii), the active ingredient, the pressure (psi or kPa) and the concentration (%).</p>
<p>1.7</p> <p>Whether or not listed among the CN codes listed in Annex V, Part B, wood in the form of chips, particles, sawdust, shavings, wood waste and scrap obtained in whole or in part from conifers (Coniferales), originating in</p> <ul style="list-style-type: none"> – Russia, Kazakhstan and Turkey, – non-European countries other than Canada, China, Japan, the Republic of Korea, 	<p>Official statement that the wood:</p> <p>(a) originates in areas known to be free from:</p> <ul style="list-style-type: none"> – <i>Monochamus</i> spp. (non-European) – <i>Pissodes</i> spp. (non-European) – <i>Scolytidae</i> spp. (non-European) <p>The area shall be mentioned on the certificates referred to in Article 13.1.(ii), under the rubric 'place of origin,'</p>

	<p>Mexico, Taiwan and the USA, where <i>Bursaphelenchus xylophilus</i> (Steiner et Bühner) Nickle et al. is known to occur.</p>	<p>or (b) has been produced from debarked round wood, or (c) has undergone kiln-drying to below 20% moisture content, expressed as a percentage of dry matter, achieved through an appropriate time/temperature schedule, or (d) 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), the active ingredient, the minimum wood temperature, the rate (g/m³) and the exposure time (h), or (e) 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>
7.3.	<p>Isolated bark of conifers (Coniferales), originating in non-European countries</p>	<p>Official statement that the isolated bark: (a) has been subjected to an appropriate fumigation with a fumigant approved in accordance with the procedure laid down in Article 18.2. There shall be evidence thereof by indicating on the certificates referred to in Article 13.1.(ii), the active ingredient, the minimum bark temperature, the rate (g/m³) and the exposure time (h), or (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 bark (including at its core), the latter to be indicated on the certificates referred to in Article 13.1.(ii), and official statement that subsequent to its treatment the bark was transported until leaving the country issuing that statement outside of the flight season of the vector <i>Monochamus</i>, taking into account a safety margin of four additional weeks at the beginning and at the end of the expected flight season, or with a protective covering ensuring that infestation with <i>Bursaphelenchus xylophilus</i> (Steiner et Bühner) Nickle et al. or its vector cannot occur</p>
8.1.	<p>Plants of conifers (Coniferales), other than fruit and seeds, originating in non-European countries</p>	<p>Without prejudice to the prohibitions applicable to the plants listed in Annex III(A)(1), where appropriate, official statement that the plants have been produced in nurseries and that the place of production is free from <i>Pissodes</i> spp. (non- European).</p>

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 B	Plants, plant products and other objects originating in territories, other than those territories referred to in Part A
I.	Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community
5.	Isolated bark of conifers (Coniferales), originating in non-European countries

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

The insect is capable to develop on plant species from the family Pinaceae (Rozhkov, 1963). In its native range, north-east Asia, it develops on larch (*Larix* spp.), fir (*Abies* spp.), spruce (*Picea* spp.) and pine (*Pinus* spp.), and it shows clear preferences for particular species (Vshivkova, 1976, 2004; Kirichenko, 2002; Kirichenko and Baranchikov, 2004a,b, 2007) (Table 5). Siberian larch (*Larix sibirica*) is the most favourable host plant for the pest, followed by the five-needle Siberian pine (*Pinus sibirica*) and the Siberian fir (*Abies sibirica*). The most severe outbreaks in Siberia occur in the stands predominantly occupied by these species (Rozhkov, 1963; Boldaruev, 1955; Baranchikov et al., 2002a, 2002b; Kharuk et al., 2017). Development on larch provides the highest survival rate (up to 75%) in neonate larvae (most sensitive to food quality) and results in the heaviest females, with high fecundity (up to 400 eggs per female) (Kirichenko and Baranchikov, 2004a,b). Other larches (*Larix kurilensis*, *L. gmelinii*, *L. cajanderi*), firs (*Abies sachalinensis*, *A. nephrolepis*) and five-needle pines (*Pinus pumila*, *P. koraiensis*) some of which are distributed in northern Siberia, in the Russian Far East, Mongolia, China, Korea serve as appropriate food sources for the pest as well (Rozhkov, 1963; Ilyinskiy, 1965; Kondakov, 1974). *D. sibiricus* may also attack Siberian spruce (*Picea obovata*) in Siberia and *P. ajanensis* in the Russian Far East (Rozhkov, 1963; Ilyinskiy, 1965). On spruces, it performs worse comparing to the favourable hosts; on *P. obovata*, its fecundity hardly reaches 150 eggs per female (Kirichenko, 2002; Kirichenko and Baranchikov, 2004a,b). The two-needle Scots pine (*Pinus sylvestris*), widely distributed in Siberia and the Russian Far East, is a poor diet for *D. sibiricus* (Kirichenko, 2002). The insect may switch to two-needle pine when there is a lack of favourable hosts, i.e. during outbreaks when all favourable hosts are entirely defoliated (Kirichenko, 2002). Development on *P. sylvestris* causes extremely high mortality in neonate larvae (up to 93%) and may drive the pest population to collapse (Kirichenko and Baranchikov, 2004a,b, 2007). However, as an exception, a localised outbreak has been recorded on Scots pine in Siberia in the Irkutsk region in the 1990s (Epova, 1999).

Outside its native range, in Europe, the pest has a high potential to damage native and exotic coniferous species which are widely distributed and have considerable commercial value. As in its native range, the list of its potential host plants in Europe is limited to the Pinaceae family (Kirichenko et al., 2008a) (Table 5). The attempts of larvae to feed on conifers of the related families Taxaceae and Cupressaceae were unsuccessful, with 100% mortality in neonates (Kirichenko et al., 2008a). Among the Pinaceae, the European larch (*Larix decidua*), the North American Douglas fir (*Pseudotsuga menziesii*) and Weymouth pine (*Pinus strobus*) are highly suitable for pest development (Kirichenko et al., 2008a,b, 2009, 2011). Feeding on these hosts results in high survival (up to 94%), larval development rates and adult fecundity (up to 340 eggs per female) (Kirichenko et al., 2008a, 2009, 2011). The Mediterranean Atlas cedar (*Cedrus atlantica*), the European firs *Abies alba* and *A. nordmanniana*, the North American fir (*A. grandis*), the Norway spruce (*Picea abies*) and the North American Sitka spruce (*P. sitchensis*) can also support the pest's development, with some variation in survival rate and larval lifespan (Kirichenko et al., 2008a, 2009, 2011). The two-needle pines distributed in Europe (*Pinus sylvestris* and *P. nigra*) and the eastern hemlock (*Tsuga canadensis*) introduced into Europe from North America are poor hosts, *P. nigra* being the poorest with up to 70% of the larvae dying in the neonate stage (Kirichenko et al., 2008a).

Table 5: Hosts species of *Dendrolimus sibiricus* in Asia (native range), and potential host species in Europe

Family	Genus	Species in Asia (native range)	Species in Europe (outside native range)
Pinaceae	<i>Abies</i>	<i>A. sibirica</i> , <i>A. sachalinensis</i> , <i>A. nephrolepis</i>	<i>A. alba</i> , <i>A. nordmanniana</i> , <i>A. grandis</i>
	<i>Larix</i>	<i>L. sibirica</i> , <i>L. kurilensis</i> , <i>L. gmelinii</i> , <i>L. cajanderi</i>	<i>L. decidua</i>
	<i>Pinus</i> (five-needle)	<i>P. sibirica</i> , <i>P. pumila</i> , <i>P. koraiensis</i>	<i>P. strobus</i>
	<i>Pinus</i> (two-needle)	<i>P. sylvestris</i>	<i>P. sylvestris</i> , <i>P. nigra</i>
	<i>Picea</i>	<i>P. obovate</i> , <i>P. ajanensis</i>	<i>P. abies</i> , <i>P. sitchensis</i>
	<i>Pseudotsuga</i>	–	<i>P. menziesii</i>
	<i>Tsuga</i>	–	<i>T. canadensis</i>
	<i>Cedrus</i>	–	<i>C. atlantica</i>

3.4.2. Entry

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

Yes, the pest is able to enter the EU territory as eggs on needles and twigs of host plants (on branches and trunks under outbreak conditions), as overwintering larvae in the litter, and as pupae attached to twigs and branches.

The main pathways of entry are:

- Plants for planting of conifers (*Abies* spp., *Larix* spp., *Picea* spp., *Pinus* spp., *Tsuga* spp., *Pseudotsuga menziesii*), possibly potted, from countries where the pest occurs. Pathway closed (Annex III A 1);
- Branches of conifers (*Abies* spp., *Larix* spp., *Picea* spp., *Pinus* spp., *Tsuga* spp., *Pseudotsuga menziesii*), including Christmas trees, from countries where the pest occurs. Pathway closed (Annex III A 1);
- Isolated bark of conifers (*Abies* spp., *Larix* spp., *Picea* spp., *Pinus* spp., *Tsuga* spp., *Pseudotsuga menziesii*) from countries where the pest occurs (import requirements specified in Annex IV-A-1 7.3.);
- Non-squared wood of conifers (*Abies* spp., *Larix* spp., *Picea* spp., *Pinus* spp., *Tsuga* spp., *Pseudotsuga menziesii*) from countries where the pest occurs (import requirements specified in Annex IV-A 1.5.);
- Direct flight. The pest is able to fly tens of kilometres.

There is trade of coniferous wood products into the EU from some countries where *D. sibiricus* is present (Russia and China). Russia is a significant exporter of wood into the EU (exporting 0.7–1.2 million tonnes of wood products into the EU in 2012–2016, according to EUROSTAT).

There are no records of interception of *D. sibiricus* in the Europhyt database. There are 115 notifications (all MSs, 2013–2017) for *Larix* wood or bark from Russia. All notifications are related to issues concerning the phytosanitary certificate (missing, incorrect, etc.).

3.4.3. Establishment

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

Yes. The host plants are largely present in the EU territory, and some of the Köppen–Geiger climatic zones (Dfc; Dfb, etc.) corresponding to the present range of *D. sibiricus* also cover some parts of the EU.

3.4.3.1. EU distribution of main host plants

Host species of *D. sibiricus* (see Section 3.4.1) are distributed throughout the EU territory (Figure 3). However, in some parts of the EU, only low quality hosts are available. For example, in the

Scandinavian peninsula the main species are *Picea abies* (intermediate quality host) and *Pinus sylvestris* (poor quality host) (see Section 3.4.1).

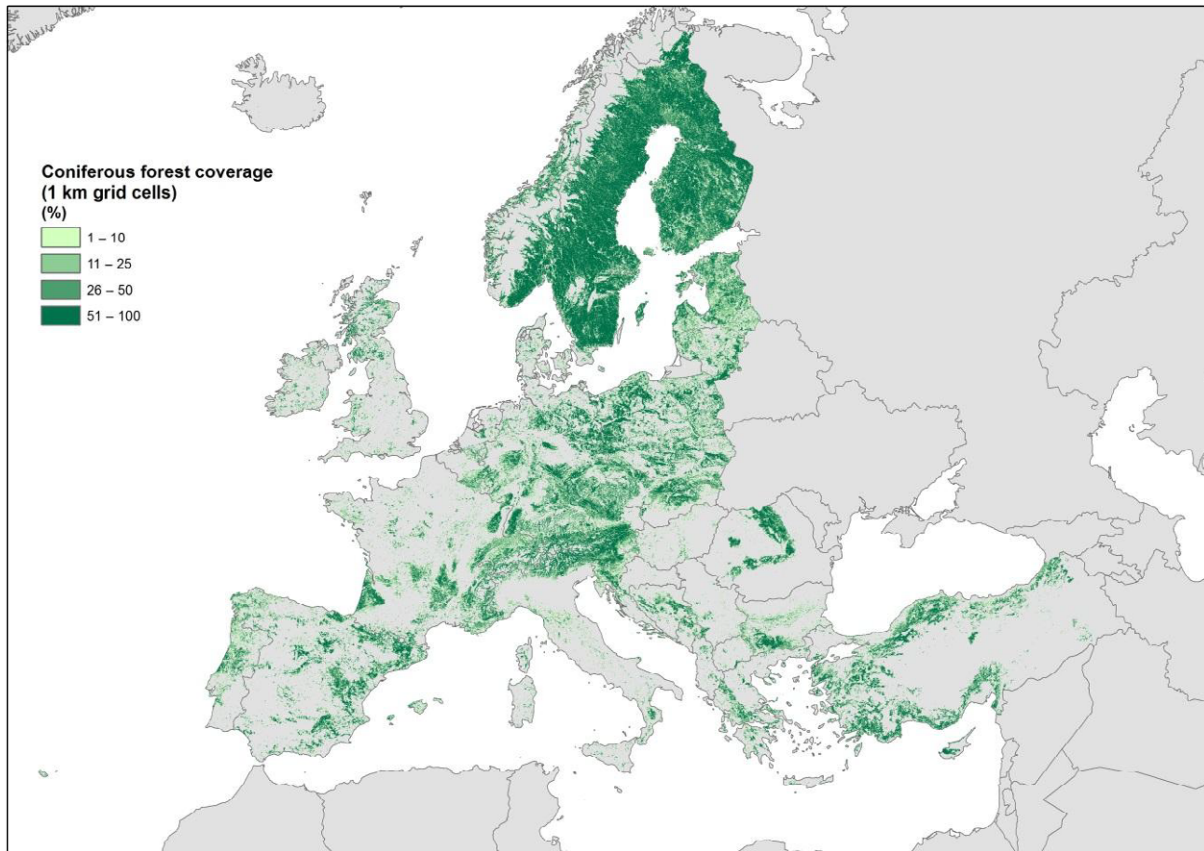


Figure 3: The cover percentage of coniferous forests in Europe with a range of values from 0 to 100 at 1 km resolution (source: Corine Land Cover year 2012 version 18.5 by EEA)

3.4.3.2. Climatic conditions affecting establishment

The known distribution area of the pest corresponds to several Köppen-Geiger climatic areas (Dfc; Dfb; etc.), which are also present in some parts of the EU territory (Figure 4) and are characterised by very cold winters and hot and dry summers. It is possible, although not scientifically established so far, that diapausing larvae of *D. sibiricus* have a limited capacity to overwinter in the litter outside of these areas, because they need to be protected by winter snow coverage.

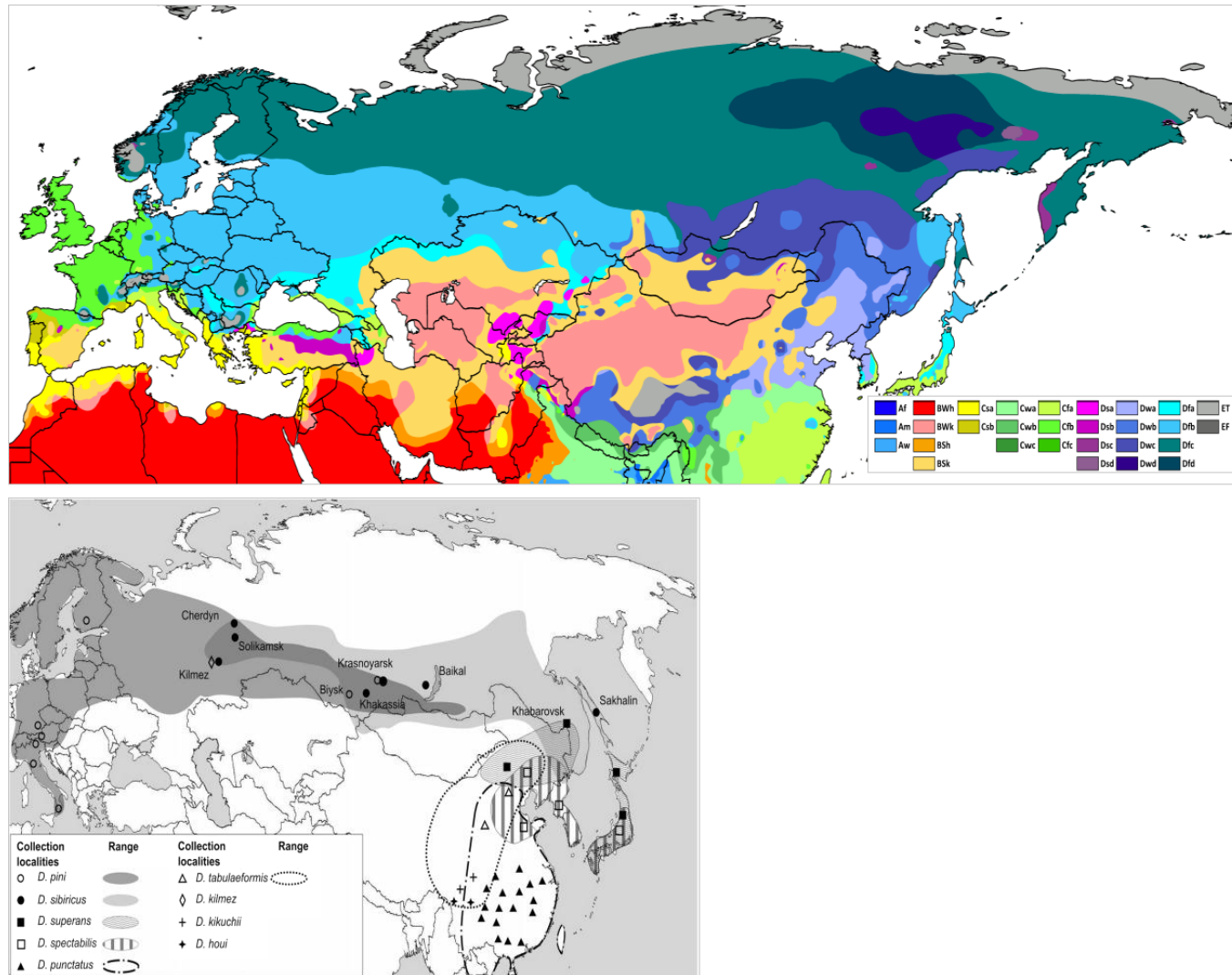


Figure 4: Correspondences between the present distribution of *D. sibiricus* (from Kononov et al., 2016) and the Köppen-Geiger climatic zones

Two climatic models have been established (Möykkynen and Pukkala, 2014; Kubasik et al., 2017) based on a Climex analysis by Flament et al. (unpublished), largely built on the distribution map by Rozhkov (1963). They conclude that the pest would find suitable climatic conditions in a large part of northern and central Europe. However, Baranchikov et al. (2010), based on an unspecified bioclimatic model, concluded that the milder winter conditions in Europe would be largely unsuitable for the survival of the larvae usually overwintering in the ground under snow cover. A recent Norwegian PRA on *D. sibiricus* (VKM et al., 2018) discussed these different approaches and concluded that Climex would not provide suitable support for modelling organisms that overwinter in the ground. Based on the distribution of very dry and hot summers and very cold winters, the Norwegian PRA concluded that most of Norway would be climatically unsuitable for the establishment of the pest.

3.4.4. Spread

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

Yes, repeated defoliation eventually kills the trees. Those that are not directly killed by defoliation are often attacked and subsequently killed by several more secondary pests.

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, because plants for planting could be attacked by *D. sibiricus*.

D. sibiricus has been observed to spread westward from its native range during the last century, reaching the Republic of Udmurtiya by the 1950s (Okunev, 1955; Talman, 1957; Rozhkov, 1963). At the beginning of the 21st century, many males were caught in pheromone traps with the Siberian moth sex pheromones in the Republic of Mariy El (500 km east of Moscow, ca 51°E) (Gninenko and Orlinskii, 2002; see also Figure 2, after Kononov et al., 2016). The capture of two individuals with the same attractant in the neighbourhood of Moscow was even reported (Gninenko and Orlinskii, 2002; Lebedeva et al., 2005). However, the accuracy of the taxonomic identification of the adults trapped in Mariy El and around Moscow has been questioned (Baranchikov et al., 2006). Trapped with the *D. sibiricus* sex attractant, these individuals were automatically identified as *D. sibiricus*, without careful study of adult morphology, whereas it is known that the related species *D. pini*, widely distributed in the European part of Russia, is also attracted to the synthetic sex pheromone of *D. sibiricus* (Baranchikov et al., 2006; Petko et al., 2016). The two species are not reliably distinguishable based on their external morphology and only the diagnostics of their male genitalia may confirm species identity (Petko et al., 2016). Thus, spreading westward of the pest itself remains uncertain (Mikkola and Ståhls, 2008).

Adults can disperse from 15 up to 50 km (Pet'ko, 2004; Buldaruev, 1960). The larvae do not balloon. Large outbreaks over 800,000 ha, attributed to drought and a local increase in the sum of daily temperature above 10°C, have been recently observed in the Yenisei range half a degree northward of the established range of *D. sibiricus* in Siberia (Kharuk et al., 2017). It is unclear, however, whether the outbreaks developed from already existing endemic populations, or were caused by insect movements northward.

3.5. Impacts

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

Yes. Adults have been reported to fly up to 50 km. Spread could also occur by the movement of plants for planting, cut branches (including Christmas trees) and, to a limited extent, non-squared wood of conifers.

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 major pathway; the insect can fly tens of kilometres.

⁴ See Section 2.1 on what falls outside EFSA's remit.

A good summary of impact can be found in EPPO (2005). *D. sibiricus* is considered as the most important defoliator of coniferous trees in Russia and Kazakhstan (Rozhkov, 1963; Epova and Pleshanov, 1995; Vorontsov, 1995; Baranchikov et al., 2001; Vinokurov and Isaev, 2002), and of *Larix gmelinii* in China (Yang and Gu, 1995). Outbreaks, often leading to massive tree death, can occur over several thousand hectares resulting in cascading ecological and economic consequences (Furiaev, 1966; Baranchikov et al., 2001). Kolomiets (1958) reports that, within 25 years (1932–1957), *D. sibiricus* damaged 7 million ha of forests in Western Siberia and Chita Oblast, causing the death of entire stands over half of this area. Similar events have been reported, e.g. by Florov (1948) and Rozhkov (1963). In 2014–2015, a Siberian moth outbreak covering about 800 thousand ha was recorded in Northern Siberia, beyond its early known range (Kharuk et al., 2017).

Tree defoliation can be repeated during 2–3 successive years which can result in tree death, especially when outbreaks occur during hot and dry summers. Larch is typically more resistant than other coniferous species to severe defoliation due to its ability to regrow needles after an outbreak (Pleshanov, 1982). However, continuous outbreaks may weaken larch trees on a large scale. For instance, during an outbreak in 1999–2002 in the Republic of Yakutia, the Siberian moth killed 0.5 million hectares of Siberian larch trees out of 8 million hectares that were infested (Vinokurov and Isaev, 2002). In boreal taiga forests, mixed stands predominated by fir, spruce and five-needle pine are severely attacked by the pest, resulting in dramatic forest decline (Boldaruev, 1955; Rozhkov, 1963; Baranchikov and Kondakov, 1997; Kharuk et al., 2017). Weakened trees are prone to attacks by bark- and wood-boring beetles, e.g. cerambycids, particularly *Monochamus urusovi* Fisch., *M. sutor* L. etc. and scolytine bark beetles, particularly *Xylechinus pilosus* (Ratzeburg), which kill those trees that have not yet been killed by repeated defoliation (Isaev et al., 1988; Soldatov et al., 2000; Rosselkhoznadzor, 2018). In addition to tree death, the damaged forests become highly susceptible to fire (Furiaev, 1966; Kharuk and Antamoshkina, 2017).

Important environmental changes are also very likely to occur due to the disappearance of forest cover over vast areas. During an outbreak, in 3–4 weeks, up to 30 tonnes per hectare of needle fragments and zoogenic matter (frass, dead bodies of larvae, pupae and adult moths) fall on the litter (Soldatov et al., 2000). Literally, during one season, all foliage in the affected tree stands is eaten by larvae and enters the soil so that the latter becomes highly fertile (Baranchikov et al., 2000). It promotes activity of soil microbiota resulting in rapid release of significant quantities of matter and energy contained in the forest litter (Perevoznikova et al., 2001). Grassy cover develops intensively and as a consequence, severely disturbed plantations are replaced by non-forest ecosystems (Baranchikov et al., 2002b). The impact of *D. sibiricus* on the carbon balance has been discussed by Baranchikov et al. (2002a), who showed that during a 2-year defoliation of stand predominantly occupied by firs, the additional emission of carbon reached 0.64 million tonnes in 1999. Reforestation of affected areas is often very complicated and takes much time, resulting in serious changes in the environment over large areas (Soldatov et al., 2000; Baranchikov et al., 2001).

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, commodity regulations and surveys (visual and by pheromone trapping) can prevent entry and establishment. However, spread can be mitigated only provided that established populations can be located early enough (which is difficult at low population densities). They might then be destroyed by chemical treatments or burned.

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

Yes, plants for planting can be produced in a pest free place of production, or a pest free area of production.

3.6.1. Phytosanitary measures

Apart from regulations regarding the main commodities listed in Section 3.4.2 (plants for planting of *Abies*, *Larix*, *Picea*, *Pinus*, *Tsuga*, *Pseudotsuga*); cut branches of the same species, including Christmas trees, isolated bark and non-squared wood of the same species, all from countries where the pest occurs), there is still the risk that the pest enters by flight, being able to cover long distances by itself (see Sections 3.1.2 and 3.4.4). Monitoring by specific pheromone trapping at borders could mitigate this risk.

Should the pest be established in the EU, production of plants for planting in pest free places of production or pest free areas of production could reduce the risks of *D. sibiricus* further spreading via this pathway.

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

- The pest is able to fly long distances, up to 50 km and possibly much more;
- Small populations are difficult to detect;
- *D. pini* is also attracted to traps baited with the *D. sibiricus* pheromones and can be distinguished from *D. sibiricus* only by the morphology of the male genitalia and DNA barcoding.

3.6.2. Pest control methods

- Destruction of infested material by burning or chipping/mulching (Poulsom, 2016);
- Adhesive tape on individual trees, to collect larvae descending to overwinter (Poulsom, 2016);
- Aerial chemical or bacterial treatments, when regulations permit;
- Natural enemies: a whole list to be found in CABI (2018).

3.7. Uncertainty

Dendrolimus pini can be confused with *D. sibiricus* if only the external morphology is taken into account. The species can be separated, though, based on the male genitalia and molecular methods.

The historical movements westward of the pest are controversial. Mikkola and Ståhls (2008) and Baranchikov et al. (2006) state that it is very slow or non-existent. The pheromone trap catches near Moscow (Gninenko and Orlinskii, 2002; Lebedeva et al., 2005) have been questioned by Baranchikov et al. (2006).

The diverging views expressed by the climatic analyses regarding the capacity of the pest to establish in parts of the EU territory request further study, in particular related to the need of a permanent winter snow coverage for the larvae overwintering in the ground.

4. Conclusions

D. sibiricus meets all the criteria assessed by EFSA for consideration as a quarantine pest for the EU territory. The species is presently absent from the EU, and thus, the criteria for consideration as a potential regulated non-quarantine pest are not met (Table 6).

Table 6: 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 is established. It can be identified to the species level using conventional entomological keys	The identity of the pest is established. It can be identified to the species level using conventional entomological keys	<i>Dendrolimus pini</i> can be confused with <i>D. sibiricus</i> if only the external morphology is taken into account. The species can be separated, though, based on the male genitalia and molecular methods
Absence/presence of the pest in the EU territory (section 3.2)	The pest is absent from the EU territory	The pest is absent from the EU territory	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
Regulatory status (section 3.3)	The pest is listed in Annex IAI of Directive 2000/29	The pest is listed in Annex I-A-I of Directive 2000/29	None
Pest potential for entry, establishment and spread in the EU territory (section 3.4)	<u>Entry</u> : the pest is able to enter into the EU territory. Pathways: plants for planting, cut branches, isolated conifer bark and non-squared wood of <i>Abies</i> , <i>Larix</i> , <i>Picea</i> , <i>Pinus</i> , <i>Tsuga</i> , <i>Pseudotsuga</i> ; autonomous flight <u>Establishment and spread</u> : host plants present in most of the EU; climate compatible or not, according to the models available to date	<u>Spread</u> : plants for planting are not the major pathway; the insect can fly tens of kilometres	Major discrepancies in the climatic models available to date; lack of biological understanding of the conditions necessary for larval overwintering
Potential for consequences in the EU territory (section 3.5)	The pests' introduction would have a major economic and environmental impact on the EU territory	The pests' introduction would have a major economic and environmental impact on the EU territory	None
Available measures (section 3.6)	Most of the pathways are closed Entry by flight remains possible and could be monitored by pheromone trapping	Plants for planting can be produced in a pest free place of production, or a pest free area of production	The movements westward of the pest in its area of origin, and the climatic constraints influencing them need further investigation
Conclusion on pest categorisation (section 4)	All criteria assessed by EFSA above for consideration as a potential quarantine pest were met	The species is presently absent from the EU, and thus the criteria for consideration as a potential regulated non-quarantine pest are not met	None
Aspects of assessment to focus on/ scenarios to address in future if appropriate	The historical movements westward of the pest are controversial. Mikkola and Ståhls (2008) and Baranchikov et al. (2006) state that it is very slow or non-existent. The pheromone trap catches near Moscow (Gninenko and Orlinskii, 2002; Lebedeva et al., 2005) have been questioned by Baranchikov et al. (2006) The diverging views expressed by the climatic analyses regarding the capacity of the pest to establish in parts of the EU territory needs further study, in particular related to the need of permanent winter snow coverage for the larvae overwintering in the ground		

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Abbreviations

COI	mitochondrially encoded cytochrome c oxidase I
COII	mitochondrially encoded cytochrome c oxidase II
DG SANTÉ	Directorate General for Health and Food Safety
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
ITS2	internal transcribed spacer 2
LD	light/dark
MS	Member State
PLH	EFSA Panel on Plant Health
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference